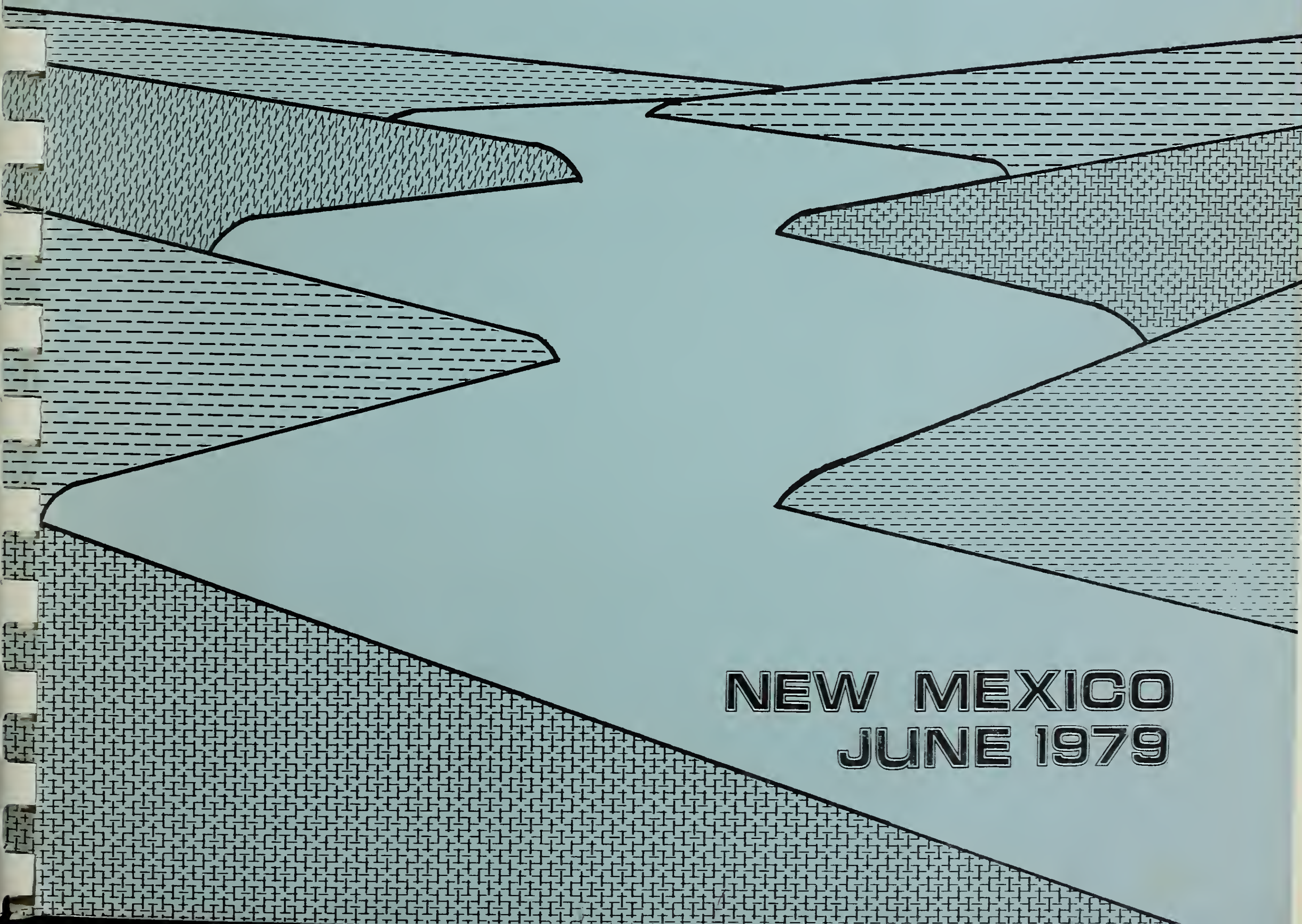
ARKANSAS-WHITE-RED RIVER BASIN

Water and Related Land Resources



NEW MEXICO
JUNE 1979

24510

ARKANSAS-WHITE-RED

RIVER BASIN REPORT

This report was prepared pursuant to Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 66 as amended). The report presents information on the natural resources of the Basin, the problems and needs associated with the water and related land resources, the opportunities for resource development, and the impacts of USDA programs.

PREPARED BY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMICS, STATISTICS AND COOPERATIVE SERVICE
FOREST SERVICE

IN COOPERATION WITH THE STATE OF
NEW MEXICO

MAY 1979

ARKANSAS-WHITE-RED RIVER BASIN

CHAPTER 1

SUMMARY

This section includes statements summarizing the objectives and scope of the study. A brief description of the basin is given, including its problems and needs. The findings and conclusions of the study cover the following sections: development potential of water and related land resources; solutions through USDA programs; and impacts of potential projects and programs.

EROSION

Wind and water erosion and the consequent sediment damage are problems. The land resource needs intensive land treatment measures to encourage good vegetative cover and reduce erosion.

LAND USE PLANNING

The lack of comprehensive and functional land use plans and zoning ordinances allows the continued development af areas that are subject to flooding. Some rangelands with high wind erosion hazards are being converted to cropland. Inadequate or nonexisting legal records of land titles are also a problem. There is a need for comprehensive land use plans that address flood and erosion hazards. A land title clearance program is needed.

IMPAIRED DRAINAGE

High water tables and salt accumulation affect a large portion of the irrigated land. A land reclamation program is needed.

WATER

Water problems include obtaining domestic supplies of water for some communities, lack of water to meet late season irrigation requirements, and inefficient irrigation water conveyance systems. Intensive water studies are needed to guide the use of limited water supplies.

WILDFIRE

There is a need to reduce fire hazard by implementing an early detection program, providing better access and transportation of firefighting forces, and providing adequate means for slash disposal.

FISH AND WILDLIFE

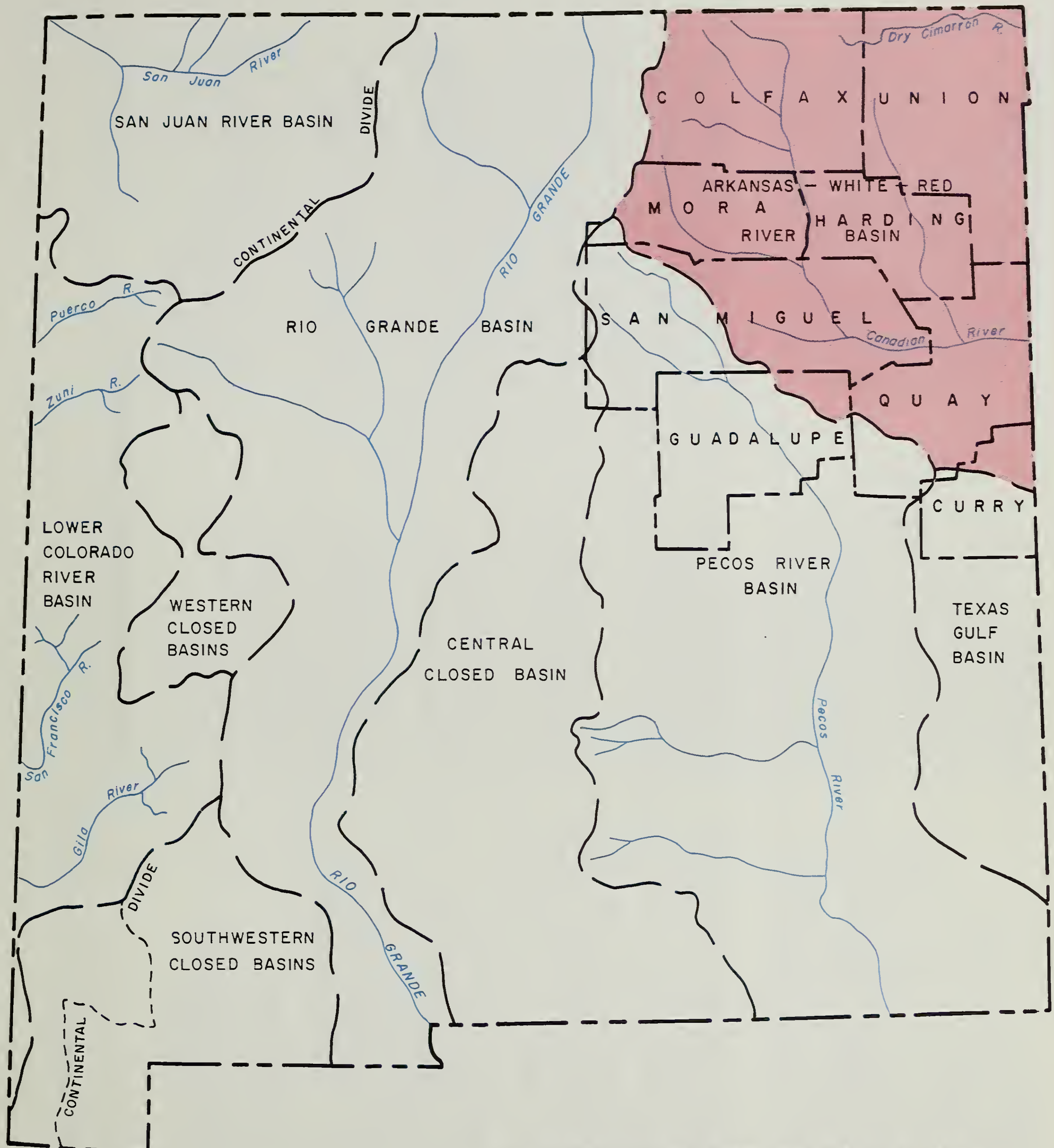
Man's past activities and land use practices have harmed the habitats of fish and wildlife. Habitat needs to be protected and improved for future recreation uses.

OUTDOOR RECREATION

Outdoor recreation suffers from overcrowded facilities, inadequate sanitation, site deterioration, and erosion. The basic need is to enlarge and improve existing facilities and to develop new recreation sites accessible to the public.

POLLUTION

Erosion and the resultant sedimentation of streams, rivers, and irrigation works is a major problem. Improper disposal of solid waste is another problem. Land treatment is needed to reduce erosion. Solid waste disposal sites need to be operated as sanitary landfills.



ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

FEBRUARY 1977

50 0 50 100 MILES

SCALE 1:3,300,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-L-22828-28

TABLE 1-1. MAJOR PROBLEMS AND OBJECTIVES

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives: First Level (Desires)	Specific Components of the Objectives: Second Level (Preferences)
National Economic Development	1. Low irrigation efficiencies on 120,000 acres.	Increased and more efficient production production of food and fiber.	Improved irrigation systems and water management.
	2. Seasonal shortage of irrigation water on about 116,000 acres of irrigated land.	Increased and more efficient production of food and fiber.	Dependable water supply throughout growing season.
	3. Excessive erosion on about 2.3 million acres of rangeland.	Increased and more efficient production of food and fiber.	Conservation land treatment and management to provide protection to rangeland from water erosion.
	4. About 4 million acres of agricultural and forest land not adequately treated to maintain the resource base.	Increased and more efficient production of food and fiber.	Conservation land treatment and management systems to maintain resource base and increase productivity.
	5. Flood damage to about 150,000 acres of agricultural land and 3,000 acres of urban land.	Increased and more efficient production of agricultural land and protection of urban property.	Flood prevention measures to provide protection to agricultural and urban land.
	6. Active wind erosion on about 24,000 acres of agricultural land.	Increased and more efficient production of food and fiber.	Conservation land treatment and management to provide protection from wind erosion.
Environmental Quality	1. Sediment deposition in streams, arroyos, lakes, reservoirs, and on floodplains.	Enhance quality of the environment for human use and enjoyment and improve wildlife habitat.	Reduce wind and water erosion and sediment in streams, arroyos, lakes, reservoirs, and on floodplains.
	2. Improper disposal of solid waste and litter.	Improve quality of landscape and natural environment.	Reduce or eliminate indiscriminate disposal of solid waste and litter.

FINDINGS AND CONCLUSIONS

DEVELOPMENT OF POTENTIAL WATER AND RELATED LAND RESOURCES

Socio-Economic

Rural areas suffer from lower than average educational levels and high unemployment rates. The economy is made up primarily of the agricultural, services, and trade enterprises. Social customs rather than economic returns often influence land use. Potential development depends on land treatment measures that will more effectively manage water and related land resources. Programs that will stimulate the local economy, improve production, provide sources of employment, and develop opportunities for self-sustainment are necessary.

Land Treatment

Various land treatment systems are considered essential for achieving the maximum protection of resources on about 9.4 million acres of rangeland, 1.2 million acres of forestland, 120,000 acres of irrigated land, and 167,000 acres of non-irrigated land. Irrigation and delivery efficiencies average about 45 percent, and could be increased to about 55 percent. Application of land treatment systems on about 9.4 million acres of rangeland could reduce erosion by 3,000 acre-feet per year in 2020. Land treatment would have a beneficial effect on about 1.2 million acres of forestland.

Agricultural Production

The largest land use is grazing. Land treatment could provide about 160,000 AUM's of additional grazing per year by 2020.

Forest Resources

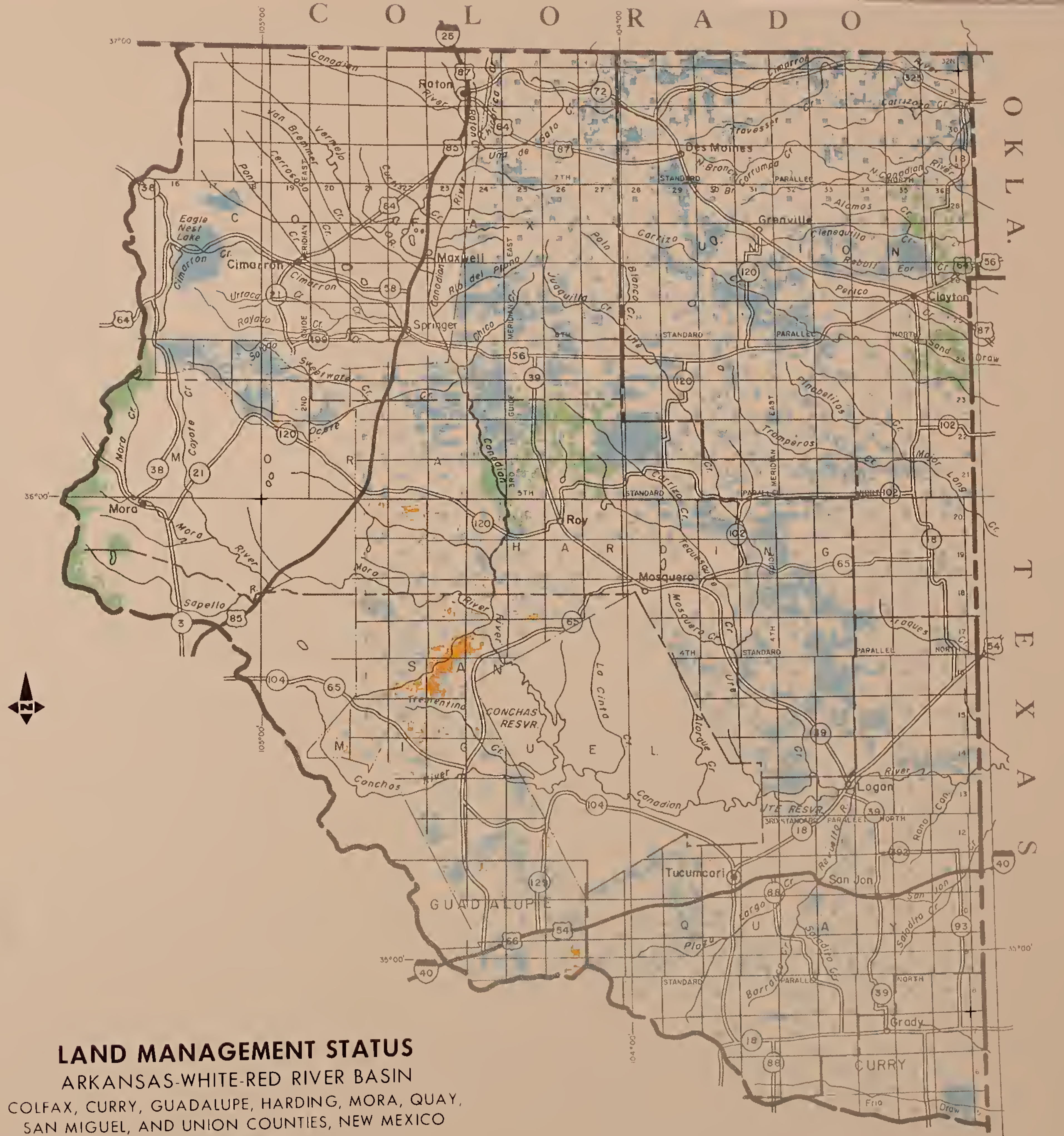
Silvicultural practices on about 1.2 million acres of forestland could increase timber growth by 62.6 million cubic feet per year. Wildlife and recreational values would be enhanced.

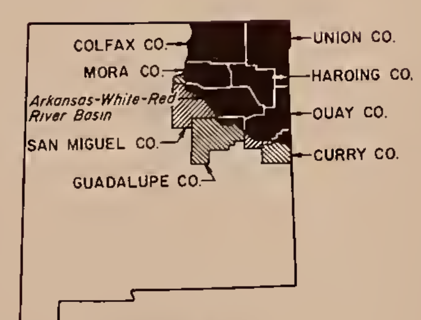
Flood Protection

Comprehensive land use planning is needed in the entire basin. Flood hazard and flood insurance studies would give cities and counties information necessary to establish zoning ordinances.

LEGEND

- State
- BLM
- Forest Service
- Other Federal
- Private





LOCATION MAP

LAND MANAGEMENT STATUS

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-21

SOLUTIONS THROUGH USDA PROGRAMS

Problems of the basin can be solved through the mutual concern and collective activities of the local people with assistance from public and private organizations. The USDA role consists of acquiring a basic and reliable inventory data base and serving as technical advisors, consultants, and managers of certain federally owned land.

Data relating to land production capabilities, erosion potential, ecological restraints, etc. should be available to all land users. Guidance in conservation, which is the wise use of the water and land resources, can solve many of the basin's problems.

The resource potential has to be determined and USDA programs should be oriented to acheive full development of the resources. Should the emphasis change, an alternative approach must be available for selection.

Land treatment systems are designed to reduce erosion, protect the land, and enhance crop, range, water, wildlife, recreation, and forest resources. Multiple use management and the recommended land treatment systems provide for the proper administration of resources, the obtaining of balance, and the coordination and programming of various land uses and activities.

IMPACTS OF POTENTIAL PROJECTS AND PROGRAMS

SOCIO-ECNOMIC

The USDA programs proposed in this report will bring about beneficial economic changes, mostly agricultural, in rural areas. Incomes over all industry groups would increase about $3.6 million by 2020. By 2020, over 92 new jobs would be created.

LAND TREATMENT

Accelerating the land treatment program on about 10.9 million acres of land in the basin will cost about $4.4 million annually and return about $10.7 million annually by 2020.

Land treatment on about 9.4 million acres of rangeland will cost about $2.9 million and return $4.1 million annually by 2020. The accelerated rangeland treatment program would increase grazing capacity 160,000 AUM and reduce sediment production 3,000 acre-feet annually by 2020.

Cropland treatment on 120,000 acres of irrigated land and 167,000 acres of nonirrigated land will cost about $200,000 and return about $5.3 million annually by 2020.

Land treatment on 1.2 million acres of forest land will cost about $1.3 million and return about $1.3 million annually by 2020. Table 9-4 shows the other projection years for the accelerated land treatment program.

CHAPTER 2

INTRODUCTION

Included in this chapter are the reasons why the river basin study was needed and the purpose and objectives of the study. A brief description of the study area is followed by an account of the authority and policy for the study. A brief description of how the study was made, uses of the report, a section on water rights administration, and New Mexico water law are included.

CHAPTER 2. INTRODUCTION

WHY THE STUDY WAS NEEDED

The primary purpose of the USDA-New Mexico cooperative river basin study is to determine where improvements can be accomplished in the use of water and related land resources, along with social, economic, and environmental impacts, through the assistance of the Department's projects and programs.

The State of New Mexico assists local people and their organizations in the conservation, development, and management of land and water resources through federal, state, and local programs and projects. An important responsibility of the State is coordinating state and federal activities to help solve water and related land problems for the people.

Knowledge of an area's basic resources, problems, needs, opportunities, and impacts is imperative before intelligent decision making can occur. One of the effective means of interpreting needed resource data is through the qualitative, quantitative, and monetary analysis of resources.

The magnitude and significance of some of the problems and possible solutions are indicated in this report. The extent to which various USDA programs assist in meeting these needs is evaluated.

The State Engineer of New Mexico, as agent for the state, recognized the need to update and increase the knowledge of the area's natural resources. This includes quantity and quality of the resource's problems, needs, opportunities, and impacts of action affecting the resources. The New Mexico State Engineer requested that the U. S. Department of Agriculture participate in a cooperative study to assist in identifying the resources and significant problems and to what extent USDA programs might meet the needs of solving these problems.

The state's objectives are to obtain an inventory of resources and problems and identify USDA programs that can help solve the problems. The New Mexico State Engineer recommended that the study and report not include the preparation of alternative plans, nor a preferred plan for development. The Department of Agriculture agency heads in New Mexico conducting the study accepted the recommendation. This report does not include alternative plans for the future nor a preferred plan for resource development.

PURPOSE AND OBJECTIVES

The purpose of this study is to help plan for the development, management, and use of water and related land resources of the Arkansas-White-Red River Basin. This study will provide the local people, the State of New Mexico, and federal agencies with information on USDA programs whereby plans for: (1) the development, conservation, and use of the natural and human resources; and (2) the improvement of the economic and social opportunities of the people can be properly addressed.

The objectives of the study are:

1. To obtain as complete as possible an inventory of the water and related land resources.

2. Identify problem areas and how existing USDA authorities could be used to help solve those problems.

3. Suggest how USDA projects and programs could be utilized to develop and improve the use of available resources for the state's benefit.

4. To enhance the national economic development (NED) by identifying and recommending feasible ways to increase the value of the nation's output of goods and services, and improving national economic efficiency.

5. To enhance environmental quality (EQ) by identifying and recommending feasible means for the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

USES OF THE REPORT

This report presents options for the use and management of natural resources, their cost, benefits, and impacts. The usefulness of the report will be in direct proportion to the interest and actions of local decision makers as they select from the options and alternatives presented. It is also a guide for local, state, and federal interests in conserving, developing, and utilizing water and related land resource programs. It informs interested parties of USDA programs of assistance that may help solve some of the basin's problems. If local decision makers wish, the report can be a basis for their pursuit of implementation actions.

Other possible uses of the report include:

1. To provide information regarding resource problems, alternative courses of action for solving these problems, and the probable results.

2. To indicate how local and federal action programs utilizing natural resources can support new industry, expand business activity, encourage growth in the economy, and conserve the land and water resource base.

3. To identify opportunities for coordinating state and federal agency programs to make maximum contributions to the conservation and use of natural resources.

4. To help soil and water conservation district officials revise and update long-range programs of work.

5. To help cities and counties evaluate development trends and use the data as a basis for projecting current and future needs.

6. To assist the regional, state, and county planning organizations (Four Corners Regional Commission, Councils of Government, Resource Conservation and Development Districts, etc.) in the identification of rural and urban problems and suggestion of ways to utilize more completely the natural, human, economic, and social resources to solve these problems.

7. To assist local, state, and federal planning organizations in obtaining public decisions about actions that have the potential to affect the quality of the environment.

DESCRIPTION OF THE STUDY AREA

The 11,342,080 acre study area (about 17,722 square miles) has about 34,100 residents. The major portion of these people reside in Tucumcari, Raton and Clayton.

The area is characterized by extremes in physical features. Elevations range from about 3,600 feet to over 13,000 feet; precipitation ranges from about 13 inches to about 30 inches annually; mean annual temperature ranges from about 36 to 58 degrees F., and frost-free period ranges from less than 30 days to more than 190 days.

Vegetative formations in the western areas include the Tundra Formation in the timberline areas of the Sangre de Cristo Mountains, Coniferous Forest Formation in the higher mountains below timberline and Coniferous Woodland Region on lower mountains and higher mesas and buttes, the Mountain Shrub Region of the Woodland Formation, and the Mountain Grassland Region of the Grassland Formation. The eastern and southern portions include the Plains and Prairie Region of the Grassland Formation, and the Riparian and Coniferous Woodland Regions of the Woodland Formation.

The study area is located in the northeast corner of the State. It is bounded on the north by Colorado, on the east by Oklahoma and Texas, on the south by the Texas-Gulf and Pecos River Basins, and on the west by the Rio Grande Basin. The basin includes all of Union, Colfax, and Harding Counties and portions of Mora, San Miguel, Quay, Curry, and Guadalupe Counties. The principal drainages are the Cimarron and Canadian Rivers and their tributaries. The basin extends about 160 miles north and south and about 130 miles east and west.

The AWR Basin in New Mexico has a varied and picturesque history. Settlement and development include exploration, mining, farming, stock raising, and irrigated agriculture. No permanent settlements were established in the area prior to 1835 because of hostile nomadic Indians. In that year, Mexican colonists entered the Mora Valley and soon extended settlement to the Ocate Creek Basin. After 1845, there was an extension of farming settlements into other valleys. The influx of American settlers began when the area was occupied by military forces.

The development of resources has grown at a fairly steady rate. Irrigated agriculture has expanded to the limit of available surface water and is approaching the limit of available ground water. Recreational activities in the mountains along the west boundary of the basin have increased rapidly in recent years.

The landownership is about 85 percent private, about 13 percent state land, and only about two percent federal.

About 62 percent of the land is rangeland used primarily for grazing livestock, 11 percent is commercial forest, 19 percent is woodlands and noncommercial timber, six percent is cropland, and the remaining two percent of the land is in roads, railroads, urban, and other miscellaneous uses. Two-thirds of the area classed as commercial forest is also used for grazing.

PHOTO 2-1. Abandoned charcoal ovens in Dawson area, Colfax County

USDA AGENCIES PARTICIPATING IN THE STUDY

USDA agencies participating in the study are the Soil Conservation Service, the Forest Service, and the Economics, Statistics, and Cooperatives Service. The study is in accordance with a mutual Memorandum of Understanding dated May 6, 1968.

AUTHORITY AND POLICY FOR STUDY

The State of New Mexico, through the State Engineer Office as sponsor and cooperating agency, requested assistance from the USDA in conducting a study on the Arkansas-White-Red River Basin in New Mexico. This study was made under authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (PL 566 as amended). This Act authorizes the Secretary of Agriculture to cooperate with the federal, state, and local agencies in investigating watersheds and river basins and other waterways for the development of coordinated programs.

This study was conducted within the scope and guidelines of the Water Resources Council's Principles and Standards for Water and Related Land Resources Planning. The effective date of these principles and standards was October 25, 1973. USDA's procedure for Planning Water and Related Land Resources, dated March 1974, was used to implement the WRC Principles and Standards.

HOW THE STUDY WAS MADE

A team approach was used throughout the study. The team included soil conservationists, economists, civil engineers, soil scientists, agronomists, geologists, biologists, hydraulic engineers, and a forester. Assistance from other disciplines was requested as needed. The team made field reconnaissances of the basin to become familiar with the area. Available reports were reviewed for data that might be helpful in determining problems and problem areas and in establishing a resource inventory base.

The Conservation Needs Inventory (CNI) data and local technicians indicated several watersheds with flooding problems. All of the identified watersheds, along with several others, were investigated to determine the extent of damage and to make a determination of the possibility of a feasible area for project action under PL 566, RC&D, or other programs or authority.

Water quality, quantity, and use inventories were made by analyzing available data and by transferring or projecting results of these evaluations.

Range resources and treatment systems were developed from data collected during the study, along with data already available. Information about fish and wildlife resources was developed from agency files and published sources. Forest and woodland inventories and treatment systems were developed from field data and information from current use.

WATER RIGHTS ADMINISTRATION-NEW MEXICO WATER LAW

NEW MEXICO STATE ENGINEER

The State Engineer is the state officer charged with administrative responsibility relating to the appropriation, distribution, and adjudication of water rights in New Mexico.

WATER RIGHTS AND LEGAL HISTORY 1/

The roots of New Mexico water law are venerable, and tap the cultural, institutional and legal wellsprings of Mexico, Spain, and ancient Rome. This state is generally aligned with other western states in the application of the doctrine of prior appropriation. However, that doctrine in New Mexico is underlain by and permeated with elements of Spanish law, custom, and methods of administration.

There is evidence from records of the colonial history of New Mexico that priority in use of water was recognized and enforced. Thus, from the provisions of Spanish colonial law, the traditions of Spanish water use and administration, and the irrigation works of the Pueblo Indians, arose the prior appropriation system now embodied in New Mexico law. The New Mexico Supreme Court has recognized that our Constitution is merely declaratory of what had been prior existing law.

The primary emphasis in the development of New Mexico water law has been in the direction of economic utilization of the resource, and water may be appropriated for any recognized beneficial use, including recreation and fishing.

SURFACE WATER

Natural Water

All natural waters flowing in streams and watercourses, whether perennial, or torrential, within the limits of the State of New Mexico,

1/ A portion of this material was abstracted from "A Summary-Digest of State Water Laws," pp. 511-575 by Richard L. Dewsnut, Dallin W. Jensen, Editors and Robert W. Sevenson, Associate Editor, National Water Commission, 1973.

belong to the public and are subject to appropriation for beneficial use. A watercourse is defined to be any river, creek, arroyo, canyon, draw, or wash, or any other channel having definite banks and bed with visible evidence of the occasional flow of water. In addition, springs which arise at the surface and form a definite channel have always been considered to be subject to appropriation.

Artificial Water

Artificial surface waters, as distinguished from natural surface waters, are defined as waters whose appearance or accumulation is due to escape, seepage, loss, waste, drainage, or percolation from constructed works, either directly or indirectly, and which depend for their continuance upon the acts of man. Artificial waters are primarily private and subject to beneficial use by the owner or developer. When artificial waters pass unused beyond the domain of the owner or developer and are deposited in a natural stream or watercourse and have not been applied to beneficial use by the owner or developer for a period of four years from their first appearance, they shall be subject to appropriation and use. No appropriator can acquire a right, excepting by contract, grant, dedication, or condemnation, against the owner or developer compelling him to continue such water supply.

GROUND WATER

Legislation was first enacted to control the use of ground water in 1927. However, in subsequent court action, this legislation was held to be unconstitutional because of certain technical defects in the act. New legislation was enacted in 1931 and, though it was not challenged until 20 years later, the constitutionality of this act was upheld. This legislation, as subsequently amended, forms the basis of the current New Mexico ground water law.

An amendment enacted in 1953 provides that all underground waters of the State are declared to belong to the public and are subject to appropriation for beneficial use. However, no permit and/or license to appropriate is required, except in basins declared by the State Engineer to have reasonable ascertainable boundaries.

WATER RIGHTS

Nature of Rights

The corpus of water while running in a natural watercourse belongs to the public, and private ownership does not extend to public streams while flowing in the water course. The appropriator's right is a right to use beneficially, while the appropriative right is a right only to the use of water; nevertheless, a water right is considered to be real property.

Beneficial use is the basis, the measure, and the limit of the right to use water in New Mexico. In early decisions, it was held that an appropriator's right is not measured by the capacity of his ditch alone, but rather by the quantity of water which was actually applied to beneficial use.

Limit of Rights

While an appropriator is entitled to his beneficial use requirements, he is not allowed to waste water. Also, a right is limited in time, as well as in quantity of water. An appropriator whose right is limited to a part of the year cannot prevent the appropriation of the same source of water by another user during other periods of the year.

Relation of Water to Land

All water in New Mexico used for irrigation purposes is, by statute, considered appurtenant to the land upon which it is used. But with the consent of the owner and a permit from the State Engineer, a right may be severed from the land and transferred to other land or other purposes.

Types of Use

The use of water in New Mexico may be acquired for any beneficial purpose and the category of such uses has not been limited by either statute or court decision.

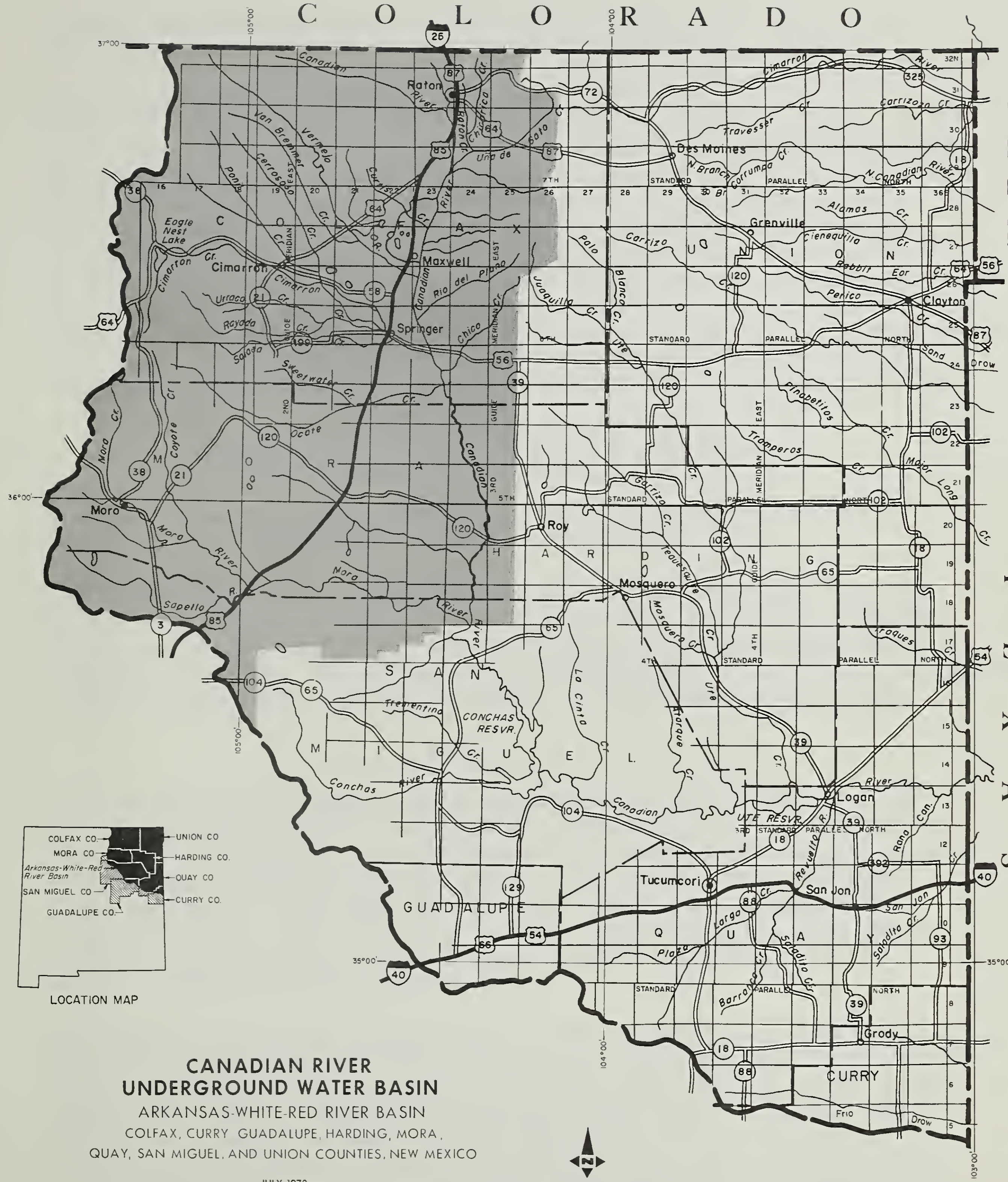
Exchange of Water

A New Mexico statute provides that water may be delivered into any ditch, stream, or watercourse to supply appropriators therefrom and, in exchange, an equivalent quantity of water may be taken either above or below the point of delivery, less a proper deduction for transmission losses. This right of exchange is subject to the provision that rights are not injured by the exchange.

Loss of Rights

Statutory forfeiture - A New Mexico statute provides that when the owner of a water right fails to beneficially use all or part of his right for a period of four years (except the waters in storage reservoirs), the unused water reverts to the public and is again considered as unappropriated public water. Legislative amendment has restricted the application of the doctrine of forfeiture. With respect to nonuse after June 1965, forfeiture can only occur after four years of nonuse and if the failure to beneficially use the water persists for one year after written notice and declaration of nonuse is given by the State Engineer.

Abandonment - The New Mexico court has noted the distinction which exists between statutory forfeiture and abandonment. Abandonment requires both an intent to abandon, as well as nonuse of the water.



CANADIAN RIVER UNDERGROUND WATER BASIN

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

LEGEND

Declared Underground Water Basin

Source:
Base Map prepared by SCS Portland Cartographic Unit from USGS 1:1,000,000 National Atlas
Thematic detail compiled by New Mexico state staff from New Mexico Ground Water Rules

However, the failure to use a water right for an unreasonable time can be construed as evidence of an intent to abandon it.

Storage of Water, Artificial Lakes, and Ponds

By statute, any person, association, or corporation, public or private, the State of New Mexico, or the United States of America, intending to construct a dam to impound the public waters of the state for any purpose, where the dam exceeds ten feet in height above the lowest natural ground surface elevation or impounds more than ten acre-feet of water shall comply with the statutory provisions relating to the appropriation and utilization of water. This requirement does not apply to stock dams whose maximum storage capacity does not exceed ten acre-feet, or to the construction of works designed solely for silt retention and which do not impound or divert water for beneficial use.

OTHER AGENCIES HAVING WATER RESOURCE RESPONSIBILITIES

The Water Quality Control Commission has been delegated principal authority for water quality control in New Mexico.

The Interstate Stream Commission has been delegated certain responsibilities in connection with interstate and other waters in which New Mexico has an interest. The commission is authorized to negotiate compacts with other states and settle interstate controversies, looking toward an equitable division of waters in interstate stream systems.

PRESENT SITUATION

The Canadian River Compact which became effective on March 17, 1952 (U. S. Congress, 66 Stat. 74) provides for an equitable distribution and division of waters of the Canadian and North Canadian River drainages in the Arkansas-White-Red River Basin. The compact does not cover those portions of the Basin in New Mexico that are drained by the Purgatorie River, the Dry Cimarron River, and Frio Draw. The compact is being administered for the State of New Mexico through the New Mexico Interstate Stream Commission.

New appropriations of surface water in the Canadian River drainage in New Mexico below Ute Dam, Purgatorie River, Dry Cimarron, North Canadian River, and Carrizo Creek may be permitted if the State Engineer determines that there is unappropriated water that could be appropriated without detrimental effect to existing rights. Conservation storage in the Canadian River drainage below Conchas Dam in New Mexico, authorized for New Mexico's use under the Canadian River Compact, has been fully allocated. Changes in points of diversion, places, and purposes of use may be made, provided no detrimental effects to existing rights will result. Changes in place or method of use or new appropriations of surface water require a permit from the State Engineer.

The Canadian River Underground Water Basin, as declared by the State Engineer, includes all of Mora County, a northern portion of San Miguel County, western three-fourths of Colfax County, and a small part of the western portion of Harding County. See the Canadian River Underground Water Basin Map. Permits from the State Engineer are necessary prior to drilling wells within the boundaries of the declared basin.

New appropriations of ground water, except for domestic and stock watering purposes, are not permitted within the Canadian River Underground Water Basin unless the State Engineer determines that the new appropriations will not impair existing rights.

ACKNOWLEDGEMENTS

Many state and federal agencies have provided data and assistance for this report. Significant contributions have been received from private individuals, business firms, and the State's universities.

CHAPTER 3

NATURAL RESOURCES

This chapter includes the qualitative and quantitative expression of land and water resources of the basin. A brief description of the topography, climate, and physiography is included to give the reader a picture of the basin. The land resources are described relative to land ownership and use, types of soils, vegetation and cover, and capability. This indicates the present condition of the basin and helps in determining the land resource potential of the basin.

The water resources of the basin, both surface and subsurface (ground water), and water quality are described. Water depletion, use, and management are also discussed. A brief qualitative description of fish and wildlife resources and scenic beauty complete the discussion of the natural resources of the basin.

CHAPTER 3. NATURAL RESOURCES — Page

TABLES

FIGURES

MAPS Follows Page

G E N E R A L   D E S C R I P T I O N

TOPOGRAPHY

Land slopes are steep in the mountains and flatten out to rolling plains to the east. Mean sea level elevations range from about 13,100 feet down to about 3,600 feet. Mountainous areas are made up of deep and steep canyons and river valleys and large, moderately sloping meadows.

CLIMATE

General climatic conditions are semiarid. Average annual precipitation varies from 13.6 inches at Newkirk to about 30 inches in the Sangre de Cristo Mountain Range. Recorded temperatures range from an average of 39.6° F. at Eagle Nest to 58.2° F. at Tucumcari. The average frost-free season is from June 26 to July 23, or 28 days at Eagle Nest; and from April 16 to October 25, or 193 days at Tucumcari.

LAND STATUS

The administration and ownership of land within the area is shown in Table 3-1.

TABLE 3-1 - LAND OWNERSHIP AND ADMINISTRATION 1/, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

COUNTY	TOTAL AREA 2/	FOREST SERVICE	BLM	DEFENSE	MISC. 3/	STATE 4/	PRIVATE
Colfax	2,412,800	9,481	261	-	5,358	278,189	2,119,511
Curry	287,360	-	-	-	-	26,040	261,320
Guadalupe	280,960	-	2,220	-	-	54,050	224,690
Harding	1,368,320	70,501	5	-	-	344,981	952,833
Mora	1,185,280	40,480	7,561	-	721	81,638	1,054,880
Quay	1,585,280	-	7,600	-	6,935	191,544	1,379,201
San Miguel	1,779,200	16,644	53,533	5	6,434	24,253	1,678,331
Union	2,442,880	57,542	503	-	680	441,946	1,942,209
TOTAL AWRB	11,342,080	194,648	71,683	5	20,128	1,442,641	9,612,975
Percent	100	1.72	0.63	0.00	0.18	12.72	84.75

Source: State Engineer 1966-1967, data

NOTES:

1/ Inland water areas are included in ownerships.
2/ Includes inland water areas.
3/ Includes national parks, monuments, U.S. Fish and Wildlife Service, Bureau of Reclamation, etc.
4/ Includes trust lands and lands deeded to specific state agencies.

PHYSIOGRAPHY AND GEOLOGY

PHYSIOGRAPHY

The AWR River Basin lies in two Physiographic Provinces (Fenneman, 1931); the Southern Rocky Mountains and the Great Plains. The Southern Rocky Mountains are made up of the Southern Sangre de Cristo Mountains along the western edge of the basin. Land forms include open low mountains and high mountains (The National Atlas, 1970) with relief from 1,000 to over 3,000 feet. The Great Plains Province has three sections (Fenneman, 1931); the Raton, the High Plains, and the Pecos sections. The Raton section consists of uplifted, dissected plains with mesas, buttes, cinder cones, and lava flows. The High Plains section, including the area of the El Llano Estacado, consists of broad low relief plains dissected by some streams. The Pecos section consists of the Upper Canadian Valleys, making a long trough carved from what was once a part of the High Plains. This section is the low valley area of the Canadian River Valley, which includes smooth plains tablelands with moderate relief and tablelands of considerable relief.

MINERAL RESOURCES

Historically, there has been a wide range of minerals mined in the Arkansas-White-Red River Basin. Precious metals such as gold and silver have been mined. Small quantities of industrial minerals such as lead, copper, tungsten, and molybdenum were mined. Sand, gravel, scoria, caliche, pumice, clay, and dimension stone have been or are being quarried in areas of the basin.

A small natural gas field has been developed in the Wagon Mound area since 1975. There is, at present, no production of oil, although there are several areas considered to have good potential for both oil and gas.

Coal is the principal mineral mined in the basin at the present time. The coal is in the Upper Cretaceous Age and Paleocene Age sedimentary rocks of the Raton Basin. Kaiser Steel Company acquired a considerable portion of the Raton Basin coal reserves in New Mexico in 1955. With this, coal mining in the basin began an upward trend after many years of decline. The 1973 production was about 1,000,000 short tons. The Raton coal field contains estimated reserves of 4.7 billion tons of bituminous coal (Kottlowski, 1964). The coal is in seams 28 inches thick or more and to depths of 3,000 feet. Most coal in the Raton field is of coking quality.

Carbon dioxide (CO_2) was discovered in 1916 in Harding County during oil exploration drilling. There are 56 wells in the basin which have encountered CO_2. Presently, the SEC Corporation of Solano, New Mexico is the only commercial producer. Their wells are located at Solano and along Ute Creek south of Bueyerous.

There are a number of construction materials available in the basin. Sand, gravel, caliche, and volcanic rock are the most common and most commonly used. Clay, scoria, crushed rock, lightweight aggregate, and

granite have all been quarried and sold in the basin. The scoria is commonly sold outside the river basin area. Sand, gravel, and caliche are seldom transported far from the source because of the relative abundance of the material and the high cost of transportation. Crushed rock is sometimes transported outside the basin.

PHOTO 3-1. Volcanic rock quarry near Des Moines, Union County.

There are large reserves of potentially good lightweight aggregate materials in the Arkansas-White-Red River Basin. Lightweight aggregate is used in concrete block, precast walls, floors, roof slabs, and highway construction. Scoria (cinders) is the only material used as lightweight aggregate presently produced in the basin. The Pierre Shale, which outcrops over a large area of the basin, has the potential to be a major source of expanded lightweight aggregate.

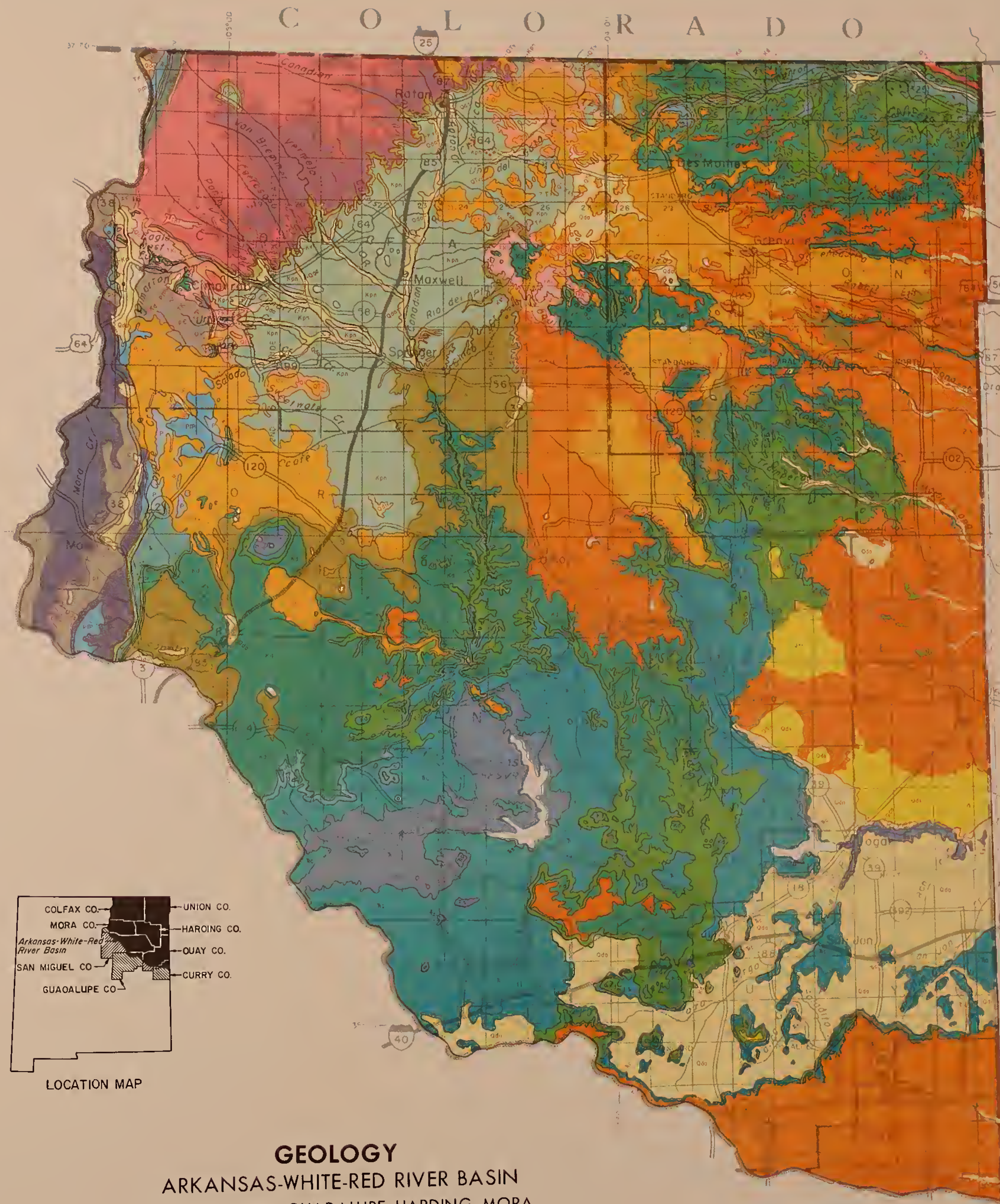
There is potential for production of clay for brick and other refractory purposes in the basin. Brick has been produced from clays in the Pierre Shale in the Raton area. Graneros Shale may have potential for clay production. Clays in the Dakota and Purgatoire Formations occur extensively in the basin and may have potential for development.

STRATIGRAPHY AND STRUCTURE

Sedimentary, metamorphic, and igneous rocks are exposed in the basin. They range in age from Precambrian to Quaternary. The Geology map shows the distribution of rock types.

LEGEND

- Qao — Alluvium, bolson deposits, pediment, terrace and other deposits (alluvial deposits and erosional remnants).
- Qds — Dune sand deposits.
- Ql — Landslide deposits. Landslide material derived from various geologic deposits, mainly shale and located on the steep slopes of mesas and buttes.
- QTv — Quaternary and Tertiary volcanic deposits. Includes basalt and basaltic andesite flows, and other extrusive and intrusive material.
- Ogallala Formation.
- Poison Canyan
- Ratan Formation.
- TKi — Igneous intrusives of various ages.
- Kvt — Vermejo Formation and Trinidad sandstone.
- Kpn — Pierre–Niobrara Formation, includes the Fort Hayes Limestone, member of Niobrara Formation.
- Cretaceous. Includes units mapped between the Fort Hayes Limestone member and the Dakota Formation on the State Geology Map Carlile Shale, Greenhorn Limestone, Greenhorn Limestone–Graneros Shale, and Graneros Shale.
- Kd — Dakota Formation. Includes Mesa Rica, Tucumcari, and Dugatoire Formations.
- Cretaceous undivided.
- Jurassic undivided. Includes Morrison Formation and the San Rafael Group.
- R — Triassic undivided.
- Rc — Chinle Formation.
- Santa Rosa Formation.
- P — Permian undivided. Includes all Permian Age rocks mapped on surface of AWR.
- PIP — Permian–Pennsylvonian undivided.
- Pennsylvanian undivided.
- Mississippian–Devonian undivided.
- Precambrian.



GEOLOGY

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by state staff from Geologic Map of New Mexico by Carle H. Dane and George O. Bachman, 1965 U.S. Dept. of Interior Geological Survey.

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From east to west the basin is a series of structural basins and uplifts or arches. The margin of the Anadarko Basin of Oklahoma and Texas runs along the upper eastern edge of the state. The Sierra Grande Uplift extends through most of the basin. The Raton and Mora Basins lie between the Sierra Grande and Sangre de Cristo Uplifts. The western margin of the basin is the Sangre de Cristo Mountains formed by the uplift.

LAND RESOURCES

LAND RESOURCE AREAS (LRA)

The individual LRA's are geographical areas characterized by particular patterns of land use, elevation and topography, climate, water, and soil. There are three significant land resource areas within the basin as follows:

Southern Rocky Mountains (RM)

This LRA is characterized by strongly sloping mountains dissected by many narrow stream valleys. High plateaus and steep-walled canyons are common. The upper mountain slopes are in forests of spruce, pine, fir, and aspen. Oak, pinyon, and juniper woodlands are at intermediate slopes; and grasses, sagebrush, and shrubs grow on lower slopes. Most of the grassland and much of the open woodland is grazed.

Pecos-Canadian Plains and Valleys (CP)

This LRA is primarily in rangeland. Rangeland at the lower elevations consists of short and mid-grasses and brush; at higher elevations, it consists of open pinyon-juniper woodland that has a grass understory. Most of the slopes of this dissected high plain are gentle to rolling; but bands of steep slopes and rough broken land border the stream valleys.

Southern High Plains (HP)

These smooth, high plains have gentle slopes except for the very steeply sloping breaks along the major rivers. Included in the area are the breaks, along the Canadian and Dry Cimarron Rivers and their larger tributaries, consisting of native grasses and shrubs used for grazing. Some of the smooth uplands are dry farmed, and an area mostly south of the Canadian River is irrigated.

SOILS

Soil is a collection of natural bodies on the surface of the earth containing living matter and supporting, or capable of supporting, plants. The soils in the basin are closely related to the patterns of geologic parent material. Many of the soils are relatively immature with physical and chemical characteristics influenced by the associated rock formations. The soil-water-plant relationships have definite effects on the economy of the area. The basin also has a variety of soil conditions that influence the quantity and quality of water.

Several soil areas influence water yield. Mountain soils absorb and store moisture from winter snows. They provide the fertile and firm footing for stands of trees and other vegetation that protect the steep slopes from erosion. Some of the water absorbed by mountain soils is released into streams throughout the year, some is evaporated, and some percolates into ground water aquifers.

The soils are extremely varied. They developed under topographic and climatic conditions, ranging from cool, moist mountains to hot, arid plains. The soils of the basin are in three Land Resource Areas: Southern Rocky Mountain Region, Pecos-Canadian Plains and Valleys Region, and the High Plains Region. See soils maps, Appendix C.

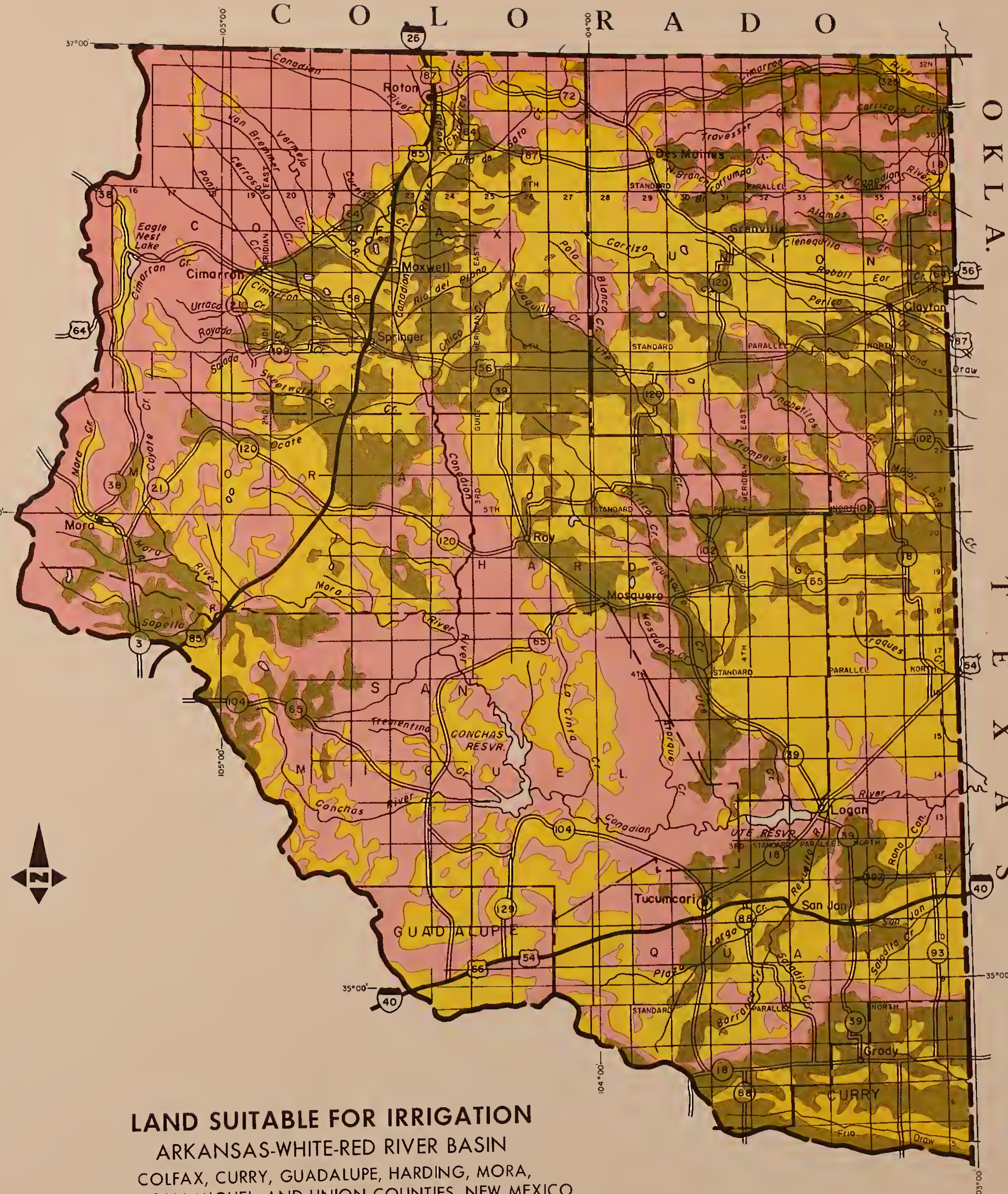
The Southern Rocky Mountain Region is the western edge of the basin. The soils developed on slopes varying from very steep and mountainous to the nearly level valley bottoms. Parent material is mainly bedrock consisting of Precambrian igneous and metamorphic rock, and younger sandstones and shale. Soils have developed on alluvial material in the mountain valleys. Shallow soils generally occur on steeper slopes. Moderately deep soils are in the flatter alluvial areas. The mountainous soils are generally stony or cobbly and moderately dark or dark-colored.

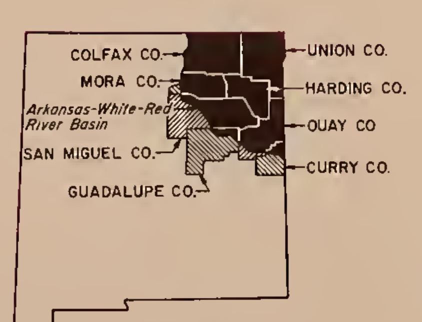
The Pecos-Canadian Plains and Valleys Region is the central portion of the basin. The region is made up of a wide variety of land forms. Slopes vary from nearly level to very steep and precipitous. The undulating topography of the plains is broken by buttes, mesas, volcanic mountains, and lava flows. The main streams have dissected steep-walled canyons, leaving large areas of bedrock exposed. Soils have developed mostly on sandstone, shales, and other sediments of Triassic, Jurassic, and Cretaceous Age and Quaternary volcanic materials. There is rough broken land with many exposures of bedrock in canyons and steep sides of mesas and buttes. Soils vary from shallow to deep depending on slopes and parent material. Soils are mainly fine to medium textured. Some soils are gravelly or cobbly. Soils are moderately dark-colored in the region.

The High Plains Region is in the eastern portion of the basin. The soils in the High Plains Region developed mainly on gently sloping and undulating lands, underlain by sands and gravels of the Ogallala Formation of Tertiary Age. Soils formed in alluvial and eolian materials are also present. Soil profiles are deep to shallow, fine to coarse textured, and dark to moderately dark-colored.

LAND SUITABLE FOR IRRIGATION

- Highly suitoble for irrigated agriculture (lands having negligible to moderate limitatians
- Moderately suitable far irrigated agriculture (lands having moderote to severe limitations)
- Unsuitable far irrigated agriculture





LOCATION MAP

LAND SUITABLE FOR IRRIGATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff from New Mexico State University data.
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SUITABILITY OF LAND FOR IRRIGATION

Soils in the area have been grouped into five different classes based on characteristics affecting their suitability for irrigation development (considering soil as a resource and disregarding availability of water) and sustained productivity (criteria for classification - Pacific Southwest Interagency Coordinating Committee). (See Table 3-2.) The principal characteristics used are slope, texture, topography, soil depth, available water capacity, permeability, alkali, drainage, erodibility, and salinity. The map, entitled "Land Suitable for Irrigation," reflects refinement of the general soil map by knowledgeable, local field technicians.

Suitability decreases from Class I to IV land because of decreasing yields and kinds of adapted crops, increasing costs of development, maintenance, and limitations of land characteristics. Class I is most desirable, Class IV is least desirable, and Class VI is not suitable for irrigation.

TABLE 3-2. - SUITABILITY OF LAND FOR IRRIGATION
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Class	Acres	Capability	Percent
I	999,490	High yields for nearly all adapted crops, minimum cost of development and maintenance	9
II	2,593,600	Moderately productive for adapted crops. Moderate cost of development and maintenance. Moderate limitations, one or more adverse land characteristics.	23
III	1,468,810	Restricted production for majority of crops. High cost of development and maintenance. Severe limitations, one or more adverse land characteristics.	13
IV	1,346,700	Few crops adapted because of severe limitations of land characteristics.	12
VI	4,933,480	Not suitable for sustained irrigation because of extreme limitations of one or more land characteristics.	43
Total	11,342,080		100

Source: Soil Associations and Land Classification for Irrigation in Curry, Harding, Quay, San Miguel, Colfax, Guadalupe, and Union Counties.

VEGETATION

The vegetative formations and associations are shown on the Present Vegetation Map.

Coniferous Forest Formation

Mixed Conifer - Engelmann spruce is found in pure stands between elevations of 10,000 to 12,000 feet. Associated species that occur less frequently are corkbark fir, limber pine and bristlecone pine.

Douglas fir, white fir and Engelmann spruce occur between the 9,000 and 11,000 foot elevations.

Mixed stands of Douglas fir and ponderosa pine occur between the 8,000 and 9,000 foot elevations.

PHOTO 3-2. Regenerated Engelmann spruce replacing aspen more than 30 years after forest fire.

Ponderosa pine-Gambel oak Association - These stands make up the largest acreage of commercial timber within the basin. Elevations range from 7,500 to 9,000 feet.

LEGEND

CONIFEROUS FOREST FORMATION

- Mixed conifer (Engelmann spruce - White fir, Douglas fir - Ponderosa pine)
- Ponderosa pine - Oak
- Ponderosa pine - Juniper

CONIFEROUS WOODLAND FORMATION

- Juniper - Pinyon (mixed grama understory)

MOUNTAIN SHRUB FORMATION

- Oak brush

PLAINS GRASSLAND FORMATION

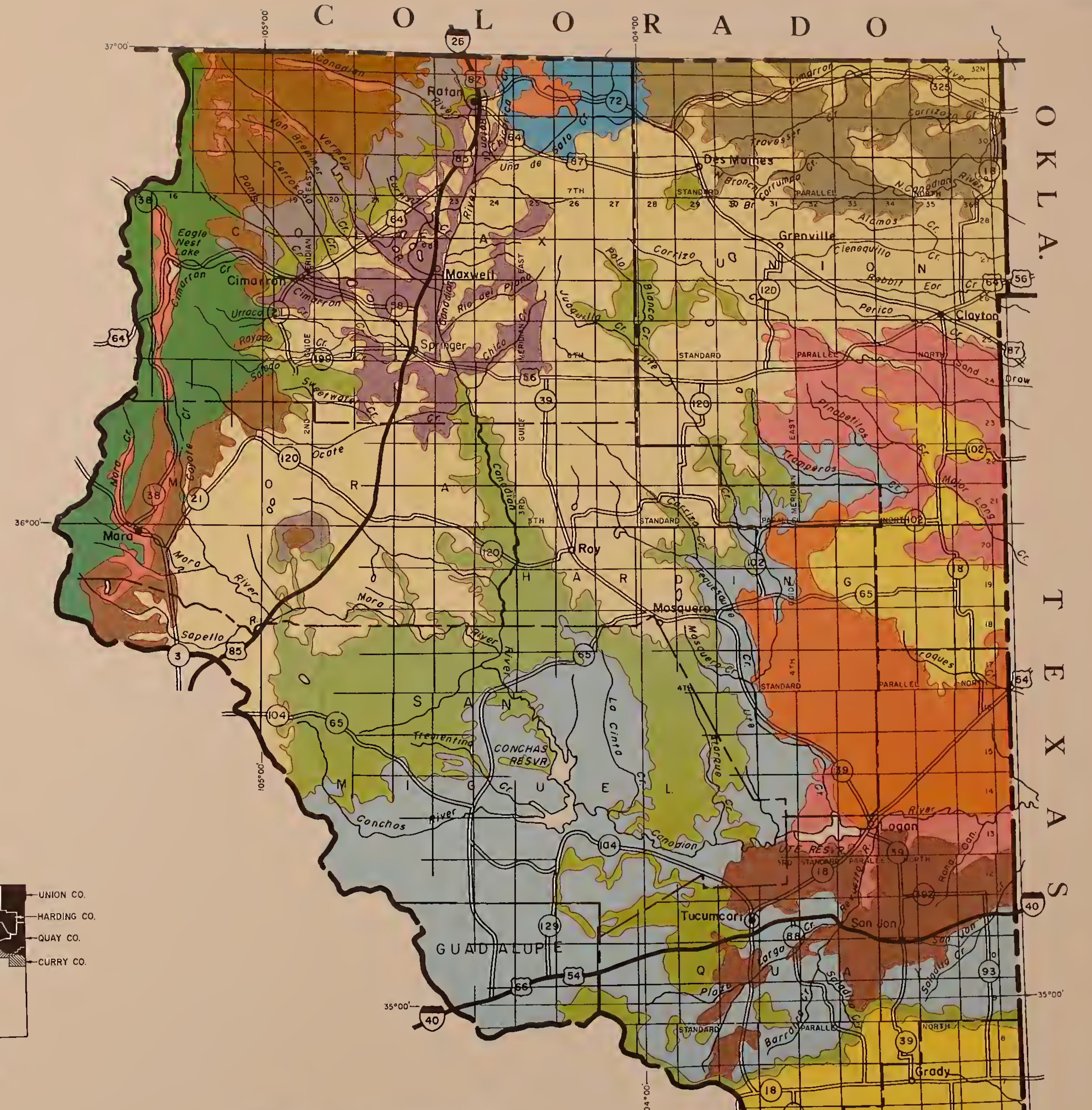
- Juniper - Mixed Grama (sideoats - blue grama)
- Blue Grama
- Mixed Grama (sideoats - blue grama)
- Blue Grama - Buffalo - Galleta
- Blue Grama - Galleta - Mesquite
- Blue Grama - Sand Dropseed - Bluestem - Mesquite
- Sacaton - Fourwing Saltbush
- Water Surface

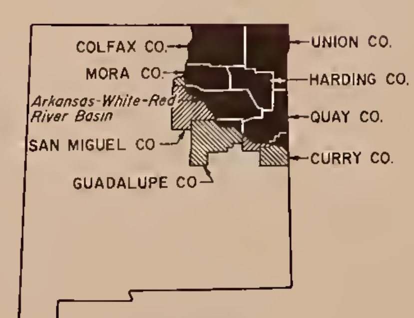
PRAIRIE FORMATION

- Sand Sage - Blue Stem

MOUNTAIN GRASSLAND

- Intermountain Grassland





LOCATION MAP

PRESENT VEGETATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

M7-EN-22828-20

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Ponderosa pine - Rocky Mountain juniper Association - Approximately 60 percent of these stands occur on lands classified as noncommercial forest. This is largely due to low productive sites and rough terrain which presently is not economical for harvesting timber.

Coniferous Woodland Formation

Pinyon-juniper type woodlands occur at elevations between 4,500 to 7,500 feet and generally occupy an area below the ponderosa pine belt. The principal species include oneseed juniper, Utah juniper, pinyon pine, alligator juniper, and Rocky Mountain juniper. The principal grasses that make up the understory are sideoats grama, muttongrass, blue grama, galleta, threeawn, Arizona fescue, and squirreltail. The understory may, at times, include Gambel oak, bitterbrush, mountainmahogany, and cliffrose.

Mountain Shrub Formation

Oak brush generally occurs on south and west-facing slopes. Species include wavyleaf oak, Gambel oak and mountainmahogany.

East of Raton, the oak brush occurs in nearly pure stands. In other areas, it occurs under pinyon, juniper and ponderosa pine. These sites provide good wildlife habitat and generally are inaccessible for livestock grazing.

Plains Grassland Formation

Juniper-mixed grama association - Scattered juniper overstory with understory of sideoats grama, blue grama and western wheatgrass. Many ranges also have rabbitbrush, broom snakeweed and threeawns.

Blue grama-western wheatgrass association - Vegetation dominated by blue grama with a cool season component of western wheatgrass. Associated species are bottlebrush squirreltail, threeawns, ring muhly, winterfat, fringed sage and broom snakeweed.

Blue grama-buffalo grass association - Blue grama dominates in association with buffalo grass, galleta, sand dropseed and threeawns. Broom snakeweed and cacti may be associated in some areas. Shallow, high lime soil inclusions will have sideoats grama and little bluestem.

Blue grama-galleta association - Dominated by blue grama with relatively high percentages of galleta and associated species of sand dropseed, threeawns, ring muhly, broom snakeweed, cacti, yucca and cholla.

Blue grama-sand dropseed-mesquite association - Sand sage, little bluestem, sideoats grama, galleta, threeawns and yucca occur throughout this area.

Sacaton-fourwing saltbush association - An area dominated by alkali sacaton and fourwing saltbush. Minor amounts of other species may occur.

Prairie Formation

Sand sage-bluestem association - Consists of little bluestem and sand bluestem in co-dominance with sand sagebrush. Associated species include silver bluestem, sand dropseed, sideoats grama, blue grama, Indiangrass, switchgrass, giant sandreed and yucca.

Mountain Grassland Formation

Arizona fescue-mountain muhly association - Located in the mountain valleys and on Johnson Mesa. Associated species are Kentucky bluegrass, tuffed hairgrass, spiked muhly and sedges.

PHOTO 3-3. High mountain grasslands supply forage for livestock and wildlife.

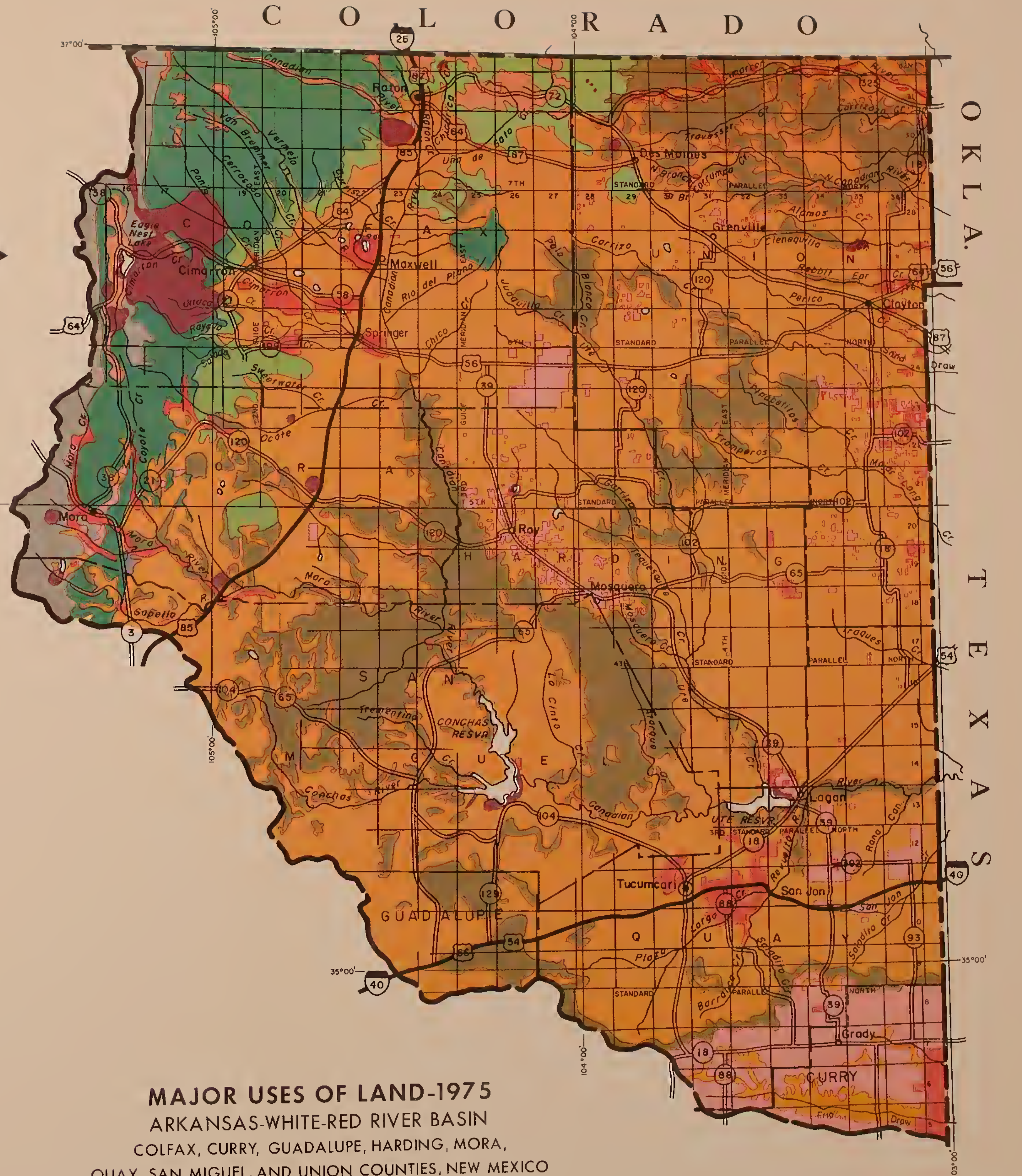
LAND USE

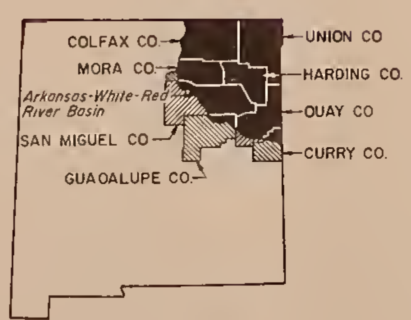
Lands in the basin are used in many ways. The vast, open grasslands and forest lands support wildlife, recreation, watersheds, etc. Some uses are nearly exclusive, such as urban, crop production, highways, and recreation development. The current emphasis in land use planning and management is utilization of the various resources in a combination that strikes a balance between providing goods and services and maintaining the values of environmental quality and social well-being.

LEGEND

- Cropland - Dry
- Cropland - Irrigated
- Rangeland - Grass
- Rangeland - Scattered Pinon and Juniper Brush
- Woodland - Grazable
- Timberland - Grazable
- Timberland - Commercial
- Mountain Grassland
- Recreation and/or Wildlife Management
- Reservoirs

More than 75% of the land in the Basin is used for grazing livestock, 8% is used for timber production and 6% is presently under cultivation.





LOCATION MAP

MAJOR USES OF LAND-1975

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

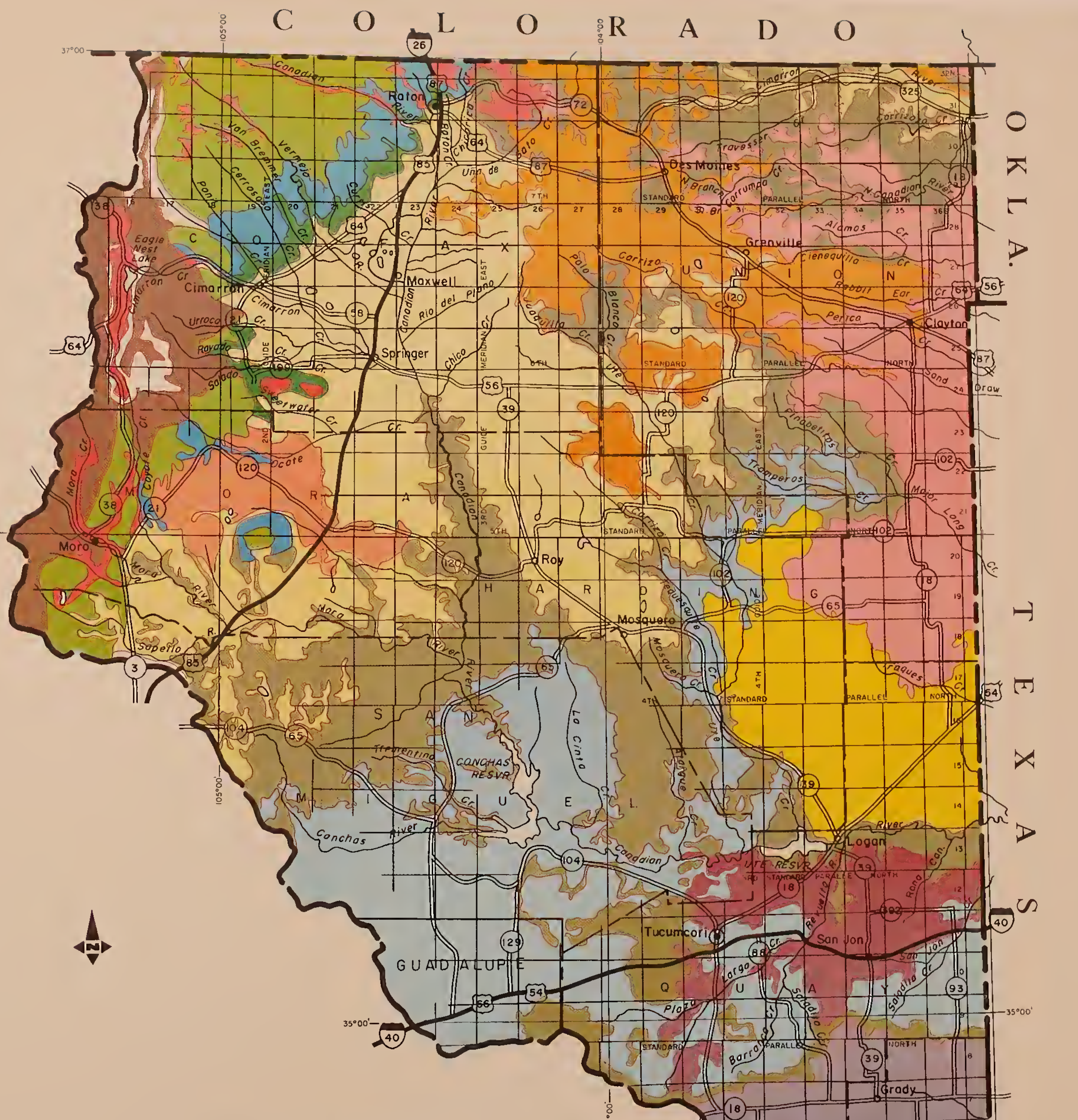
M7-EN-22828-1

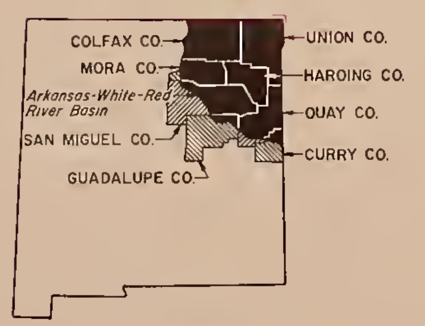
RATES OF STOCKING

(Based on Fair to Good Range Condition Under Average Rainfall)

	No Significant Grazing
	50-70 Acres/AUM *
	15-25 Acres/AUM
	20-30 Acres/AUM
	2.9-4.2 Acres/AUM
	4.2-5.8 Acres/AUM
	5.5-8.8 Acres/AUM
	8.0-12.0 Acres/AUM
	3.0-3.8 Acres/AUM
	4.0-6.5 Acres/AUM
	3.0-4.0 Acres/AUM
	4.7-7.2 Acres/AUM
	3.9-6.3 Acres/AUM
	4.0-6.2 Acres/AUM
	4.2-6.7 Acres/AUM
	3.2-5.7 Acres/AUM

* Animal Unit Month





LOCATION MAP

RATES OF STOCKING

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1: 1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-14

CROPLAND

There are 683,567 acres of cropland in the basin of which 155,780 acres have been developed for irrigation. Irrigated lands are generally developed along major streams where suitable water supply is available. Pump irrigation is primarily on the eastern side of the basin. Irrigation systems range from primitive to modern. Grazing of livestock on crop aftermath is a common practice. Other uses of cropland include wildlife habitat, recreation, and hunting.

PHOTO 3-4. Sprinkler irrigated cropland in the eastern part of the basin.

Non-irrigated cropland generally occurs in the southeastern portion of the basin in southern Quay and northern Curry Counties. Small tracts of dry farming are scattered throughout the eastern part. The major limiting factor to dryland crop production is lack of moisture.

RANGELAND

The predominate use of rangeland is grazing of the native forage by wildlife and domestic livestock. There are variations in the capacity of the land because of differences in precipitation, elevation, topography, soil, and vegetation type. Some areas cannot be grazed because of rough topography, dense timber and brush, barren lands, and lack of water for livestock and wildlife use.

Forage growth usually follows periods of precipitation. This growth occurs in two periods--in the spring (February and March); and in mid-summer (July and August). The most critical periods of water shortage, however, occur in May and June and in September and October. The spring growth is from winter moisture and possible spring showers.

Land suitable for livestock use will sustain the range livestock industry under proper management and will remain an important part of the basin's economy. The productivity of the land and the vegetative cover can be improved by using appropriate livestock management techniques and management on the rangeland.

PHOTO 3-5. Well managed ranges will support a variety of grasses for livestock and wildlife use.

FOREST LANDS

Forest lands in the basin comprise about 30 percent (3.4 million acres) of the area. Two broad classifications have been used to describe these lands. They are (1) commercial and (2) non-commercial forests.

Commercial Forest Lands - have the capability of growing at least 20 cubic feet of timber per acre per year and are suitable now or in the future for timber harvest. These areas also provide recreation, wildlife habitat, watershed protection, and some forage for livestock.

The commercial forest encompasses about 1.2 million acres and contains about 2.8 billion board feet of timber. This amounts to about 19 percent of the state's commercial forest acreage. The principal trees used for lumber are Ponderosa pine, Douglas fir, and Engelmann spruce. They occur between elevations of 7,500 to 11,000 feet.

The average growth potential of the commercial forest lands have a site index of 60, i.e., a 100-year-old tree will obtain a height of 60 feet. During a 120-year rotation period for a timber crop, the average tree growth would be approximately 20 cubic feet per acre per year. The potential yield on growing stock, which represents about 85 percent of the commercial forest land, would be about 35 million cubic feet (175 million board feet) annually.

Forest products harvested in the basin in 1974 included: 20 million board feet sawlogs; 375,000 linear feet of house logs, mine props and ties; 800 cords of fuelwood; 10,000 linear feet of post and poles; 12,000 Christmas trees and an unknown amount of balled root stock.

Ninety-five percent of the forested land in the river basin is in State and private ownership. The majority of these lands are not being managed for wood or wood fiber production. In most instances, the primary uses and revenue received from timbered lands are livestock grazing, big game fee hunting, and outdoor recreation.

<u>Noncommercial Forest Lands</u> - There are approximately 2.2 million acres of noncommercial forest land in the basin. These are lands which support various types of tree cover but lack the capability of growing 20 cubic feet of wood per acre per year or are not suitable for timber harvest. These areas generally provide wildlife habitat, watershed protection, recreation, and forage for livestock.

The pinyon-juniper woodlands generally occur on the shallow rocky soils at elevations of 4,500 to 7,000 feet. Products from these trees currently have markets for fence posts and fuelwood. Future markets for wood fiber such as pulp and particle board could increase the value of these trees.

TABLE 3-3 - AREA OF COMMERCIAL FOREST LAND BY TYPE, OWNERSHIP, AND VOLUME (MILLION BOARD FEET) ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Ownership	COLFAX		COUNTY MORA		SAN MIGUEL		TOTAL	
	Thousand Acres	MMBF	Thousand Acres	MMBF	Thousand Acres	MMBF	Thousand Acres	MMBF
Private								
Englemann Spruce	15	75	-	-	-	-	15	75
Spruce-Fir	147	588	124	248	1	3	272	839
Doug. Fir-P. Pine	28	126	-	-	-	-	28	126
P. Pine-Oak	374	816	102	153	28	43	504	1012
P. Pine-Juniper	176	176	38	50	-	-	214	226
Aspen	26	105	5	19	-	-	31	124
	766	1886	269	470	29	46	1064	2402
State								
Spruce-fir	46	100	2	4	-	-	48	104
Doug. Fir-P. Pine	20	60	-	-	-	-	20	60
P. Pine-Oak	21	50	9	13	-	-	30	63
P. Pine-Juniper	-	-	2	3	-	-	2	3
Aspen	3	10	-	-	-	-	3	10
	90	220	13	20	-	-	103	240
National Forest								
Spruce-Fir	6	27	18	47	6	11	30	85
Doug. Fir-P. Pine	2	9	-	-	-	-	2	9
P. Pine-Oak	-	-	19	33	13	19	32	52
Aspen	1	4	4	14	-	-	5	18
	9	40	41*	94	19**	30	69	164
Total***	865	2164	323	584	48	76	1236	2806

* Includes 10,240 acres within Pecos Wilderness
** Includes 5,650 acres within Pecos Wilderness
*** Does not include 440 acres of BLM lands

Notes:
Acres determined from vegetation map which was prepared by River Basin Staff with input from New Mexico State District Foresters, private land managers and SCS field personnel.

Estimated volume, million board feet, of commercial timber presently on Forest lands. Volume included trees over 9" dbh in size. Data based on Mora County Timber Resource Inventory, National Forest Timber inventories and cruise data from private lands.

PHOTO 3-6. Forest land used for housing and recreation.

PHOTO 3-7. Forested area, west fork of Luna Creek, Carson National Forest, Mora County.

URBAN (and) BUILT-UP

Urban and built-up areas include lands subdivided for residential and industrial uses and occupy about 77,600 acres. Individual development ranges from small villages to the larger towns such as Raton, Clayton, and Tucumcari. Included in urban uses are residential, business, and some industrial developments.

ROADS

The land used for road systems in the basin is about 71,000 acres. The major interstate freeways have brought changes in land use. Favorable climatic conditions are a factor in attracting traffic for both private and commercial uses. Interstate highways have reduced travel time to recreation areas.

OUTDOOR RECREATION

Nearly all of the land is used for some form of recreation. Recreation activities include hiking, sightseeing, pleasure driving, camping, picnicking, rockhounding, hunting, fishing, and winter sport activities. Outdoor recreation is available year round. The most valuable areas are generally those having special attraction such as rivers, streams, lakes and reservoirs, coniferous forest, and unusual archeological, historical, geological, or scenic sites.

INLAND WATERS

Inland water areas comprise 24,734 acres and include lakes and reservoirs with 40 surface acres or more. Natural lakes located in the higher forested areas make up a small percentage of the acreage. The major streams are all controlled by reservoirs that are used for water-oriented recreation. Conchas and Ute Reservoirs, the largest reservoirs in the basin, make up 47 percent of the water surface acres. There are other numerous small impoundments, mostly for livestock watering, scattered throughout the basin.

PARKS AND REFUGES

Included are state and national parks and lands administered by organizations in the federal and state governments. They are used primarily for recreation with emphasis on the preservation of the various resources. There are 71,952 acres in this category.

PHOTO 3-8. Fishing, camping, and picnicking are among the most popular family outdoor recreation activities in the Arkansas-White-Red River Basin.

TABLE 3-4 - LAND USE, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO, 1975

COUNTY	TOTAL AREA	INLAND 1/ WATER	URBAN 2/ and built-up	ROADS 3/	CROPLAND IRR. 4/	CROPLAND DRY	DEFENSE 5/	PARKS F&W 6/	COMM. TIMBER 7/	GRAZING WOODLAND 8/	GRAZING GRASS 9/	GRAZING TOTAL
Colfax	2,412,800	7,248	26,000	14,070	33,200	17,020	-	40,286	865,000	291,000	1,118,976	1,409,976
Curry	287,360	-	180	4,951	22,500	150,500	-	-	-	4,000	105,229	109,229
Guadalupe	280,960	-	120	1,715	-	-	-	-	-	27,000	252,125	279,125
Harding	1,368,320	240	7,446	7,621	5,120	58,400	-	2	-	297,000	992,491	1,289,491
Mora	1,185,280	1,411	5,885	6,475	15,460	9,950	-	22,324	323,000	107,000	693,775	800,775
Quay	1,585,280	4,675	16,634	14,474	42,800	200,397	-	633	-	193,000	1,112,667	1,305,667
San Miguel	1,779,200	10,843	2,740	5,948	3,720	-	5	7,207	48,000	698,000	1,002,737	1,700,737
Union	2,442,880	317	18,616	16,028	32,980	91,520	-	1,500	-	541,000	1,740,919	2,281,919
Total AWR	11,342,080	24,734	77,621	71,282	155,780	527,787	5	71,952	1,236,000	2,158,000	7,018,919	9,176,919
Percent	100	0.22	0.68	0.63	1.37	4.65	0.00	0.64	10.90	19.03	61.88	80.91

Source: SEO 6/6/74: Parks, Comm. Timber, and Grazing revised by River Basin Staff 5/6/75

1/ Inland water areas include lakes and reservoirs with 40 surface acres or more. There are no streams in the basin 660 feet or more in width.

2/ Urban and built-up areas include lands subdivided for residential and industrial uses.

3/ The area for roads does not include roads in parks, military reservations and fish and wildlife refuges.

4/ This includes all land developed for irrigation; not all of this is irrigated every year.

5/ Some of the defense lands are also used for grazing.

6/ The areas for parks and fish and wildlife include state and national parks and lands administered by the U. S. Fish and Wildlife Service and the State Game and Fish Department.

7/ Commercial timber areas include land capable of producing saw timber not withdrawn from timber utilization and is economically available. Practically all of the commercial timber areas are also used for grazing and recreational purposes. (Updated by River Basin Field Staff.)

8/ Noncommercial forest and woodlands include productive-reserved, unproductive nonreserved and unproductive-reserved.

9/ Rangeland areas include grass, shrubs, and brush but do not include cropland that may be used for grazing.

WATER RESOURCES

SURFACE WATER SUPPLY

The average annual precipitation is about 16.0 inches over the entire area, or 15,120,000 acre-feet. The average runoff is 770,000 acre-feet and 388,000 acre-feet may be available for withdrawal. The remainder is depleted by natural vegetation, evaporation, and percolation. The 388,000 acre-feet is total useable surface water and is broken down by drainage as shown in Table 3-5 and on the Surface Water Supply map. Of the 388,000 acre-feet available for withdrawal, 239,000 acre-feet are available for depletion. An annual average of 202,000 acre-feet are depleted by identifiable uses (See Table 3-6). There are 37,000 acre-feet occurring near the New Mexico-Texas state line that are not controlled.

This 37,000 acre-feet includes 6,000 acre-feet in the Dry Cimarron River and tributaries, and 31,000 acre-feet in Canadian River and tributaries below Ute Dam. This quantity of water may not be useable due to: a) limitations imposed by the Canadian River compact, and b) the water occurs below areas of current use in the case of Dry Cimarron water.

TABLE 3-5 - ESTIMATED SURFACE WATER SUPPLY (ROUNDED TO NEAREST 1000 FEET) ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO, 1975

DRAINAGE	1000 ACRE-FEET
Canadian River above Conchas Dam	249
Canadian River below Conchas Dam	59
Ute Creek	20
Dry Cimarron River	28
North Canadian River and Tramperos Creek	32
Total	388

TABLE 3-6 - SURFACE WATER DEPLETIONS AND PERCENTAGE OF TOTAL SUPPLY, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO 1970

Use	Depletions Acre-Feet	Depletions Percent	Percent of Total Surface Depletion 1/
Municipal	700	.35	.30
Rural	200	.10	.08
Irrigation	117,260	58.05	49.06
Livestock 2/	12,600	6.24	5.27
Fish & Wildlife (Recreation)	18,590	9.20	7.78
Reservoir Evaporation	52,650	26.06	22.03
TOTAL	202,000 3/	100.00	84.52

1/ Total surface supply available for depletions is 239,000 acre-feet with a portion occurring below locations of current users.

2/ Includes evaporation from stockponds.

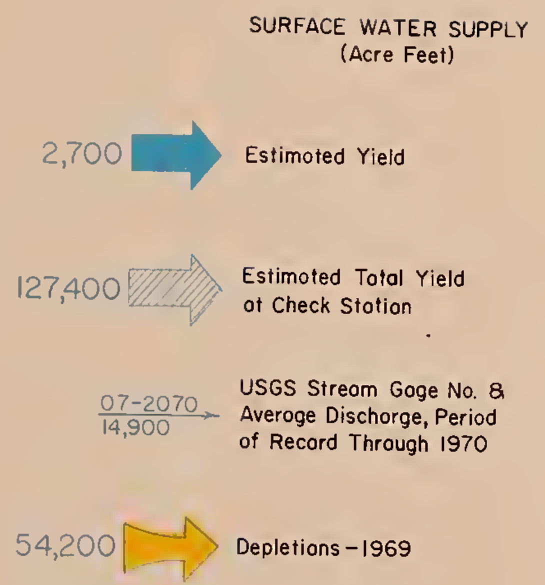
3/ There may be 37,000 acre-feet available for depletion at remote locations near the New Mexico-Texas state line. This may not be usable due to location or limitation imposed by the Canadian River Compact.

(a) Dry Cimarron River and tributaries - 6,000 ac. ft.

(b) Canadian River and tributaries below Ute Dam - 31,000 ac. ft.

Stream record analyses were made for selected stations, and average annual discharge in acre-feet and associated drainage areas are shown in Table 3-7; the Average Annual Water Yield Map shows areal distribution.

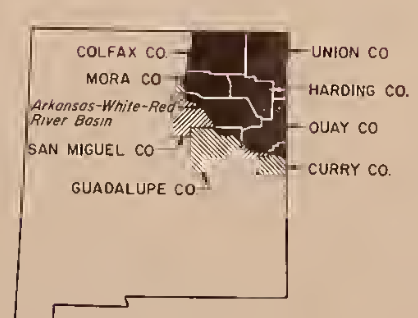
Surface water storage facilities include Eagle Nest Reservoir, Maloya Lake, Lake Dorothy located in Colorado, Lake Alice, Black Lake, Miami Reservoir, Lake Isabel, several reservoirs in the Vermejo Irrigation Project, Conchas Reservoir and Ute Reservoir. Also, there are many playa and other natural lakes. Water stored in these reservoirs and lakes serves many uses and purposes: municipal and industrial, livestock and domestic, irrigation, fish and wildlife, and recreation.



SURFACE WATER SUPPLY
Acre Feet
ARKANSAS-WHITE-RED RIVER BASIN
COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,000,000



LOCATION MAP

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

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PHOTO 3-9. Cimarron Creek. Mountain streams are a major contributor to water supply.

PHOTO 3-10. Moreno Valley. Winter snow pack is an important source of water supply.

PHOTO 3-11. Eagle Nest Reservoir. Surface water storage reservoirs are important in stretching the water supply through the summer months and drought years.

PHOTO 3-12. Cimarroncito Lake. Small mountain lakes contribute to water resources in the basin.

TABLE 3-7 - AVERAGE DISCHARGE IN ACRE-FEET WITH ASSOCIATE DRAINAGE AREAS FOR SELECTED STATIONS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

STATION NAME	STATION NUMBER	DRAINAGE AREA SQ. MILES	AVERAGE DISCHARGE ACRE FEET	YEARS OF RECORD
Cimarron River near Guy, NM	07153500	545	8,470	1942-1973
Cimarron River near Kenton, OK	07154500	1,106	19,040	1950-1973
Canadian River near Hebron, NM	07199000	229	5,310	1946-1973
Vermejo River near Dawson, NM	07203000	301	14,260	1927-1973
Cimarron Creek near Cimarron, NM	07207000	294	14,910	1950-1973
Rayado Creek at Sauble Ranch	07208500	65	9,560	1927-1970
Cimarron River at Springer	07211000	1,032	12,900	1926-1973
Canadian River near Taylor Springs, NM	07211500	2,850	67,090	1940-1957 1965-1973
Mora River near Holman, NM	07214500	57	9,780	1953-1973
Mora River at La Cueva, NM	07215500	173	20,430	1932-1973
Mora River near Golondrinas, NM	07216500	267	25,430	1924-1973
Coyote Creek above Guadalupita, NM	07217100	71	7,110	1956-1973
Coyote Creek near Golondrinas, NM	07218000	215	8,690	1930-1973
Sapello River at Sapello, NM	07220000	132	17,530	1956-1973
Mora River near Shoemaker, NM	07221000	1,104	43,690	1928-1973
Canadian River near Sanchez, NM	07221500	6,015	152,900	1935-1973
Conchas River at Variadero, NM	07222500	523	12,100	1936-1973
Ute Creek near Logan, NM	07226500	2,060	20,580	1942-1973
Canadian River 1/ at Logan, NM	07227000	11,140	281,100	1912-1913 1927-1938
Canadian River 2/ at Logan, NM	07227000	11,140	184,000	1939-1962
Canadian River 3/ at Logan, NM	07227000	11,140	29,340	1963-1973
Revuelto Creek near Logan, NM	07227100	786	39,200	1959-1973
Tramperos Creek near Stead, NM	07227200	556	3,170	1966-1973

Source: USGS Water Supply papers

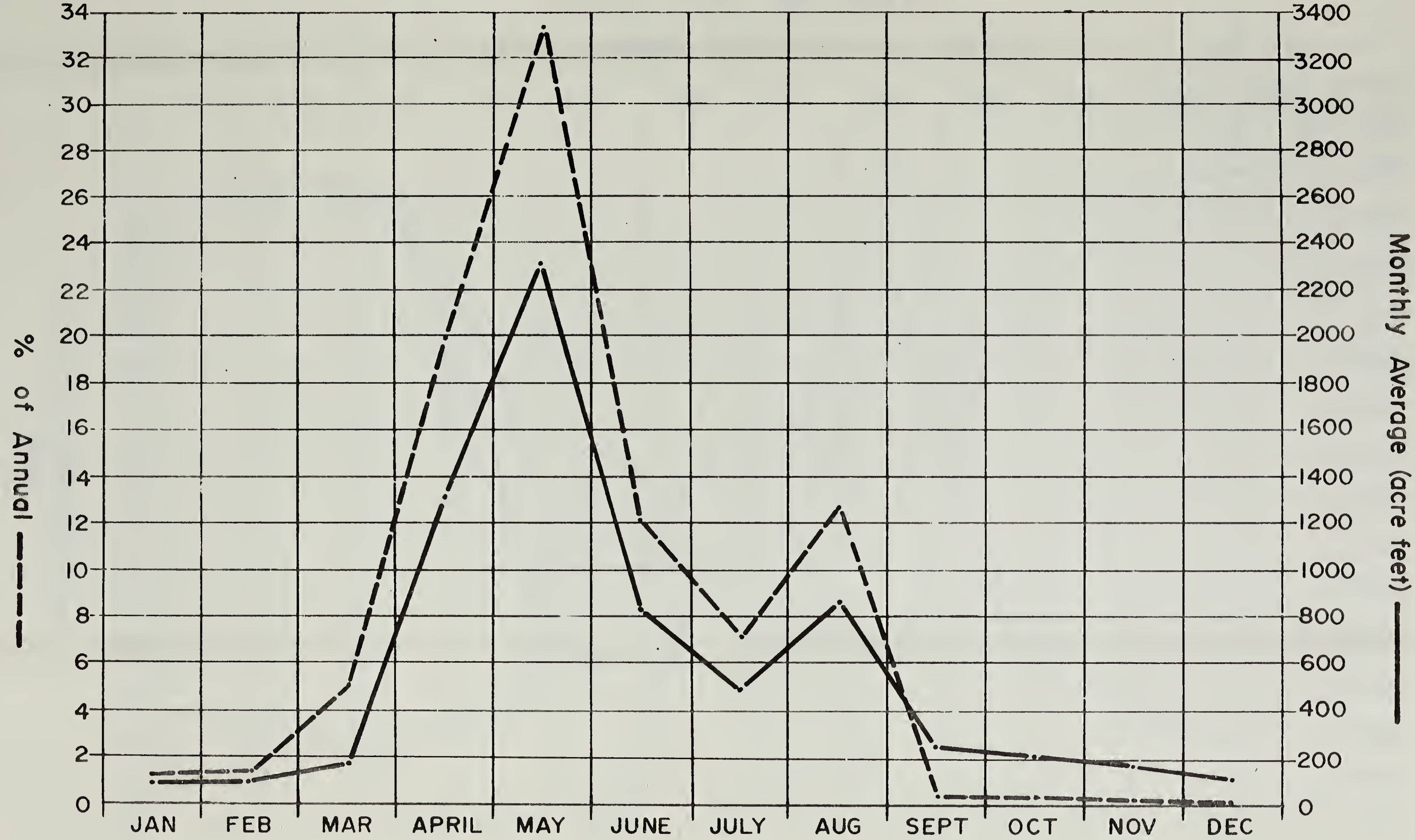
1/ Prior to construction of Conchas Dam.
2/ Prior to construction of Ute Dam.
3/ Post construction of both Conchas and Ute Dams.

GEOGRAPHICAL AND SEASONAL DISTRIBUTION OF WATER

Typical Monthly Distribution of Surface Water indicates the difference in timing of runoff in the mountainous area and the plains. See Figures 3-1, 3-2, 3-3, and 3-4.

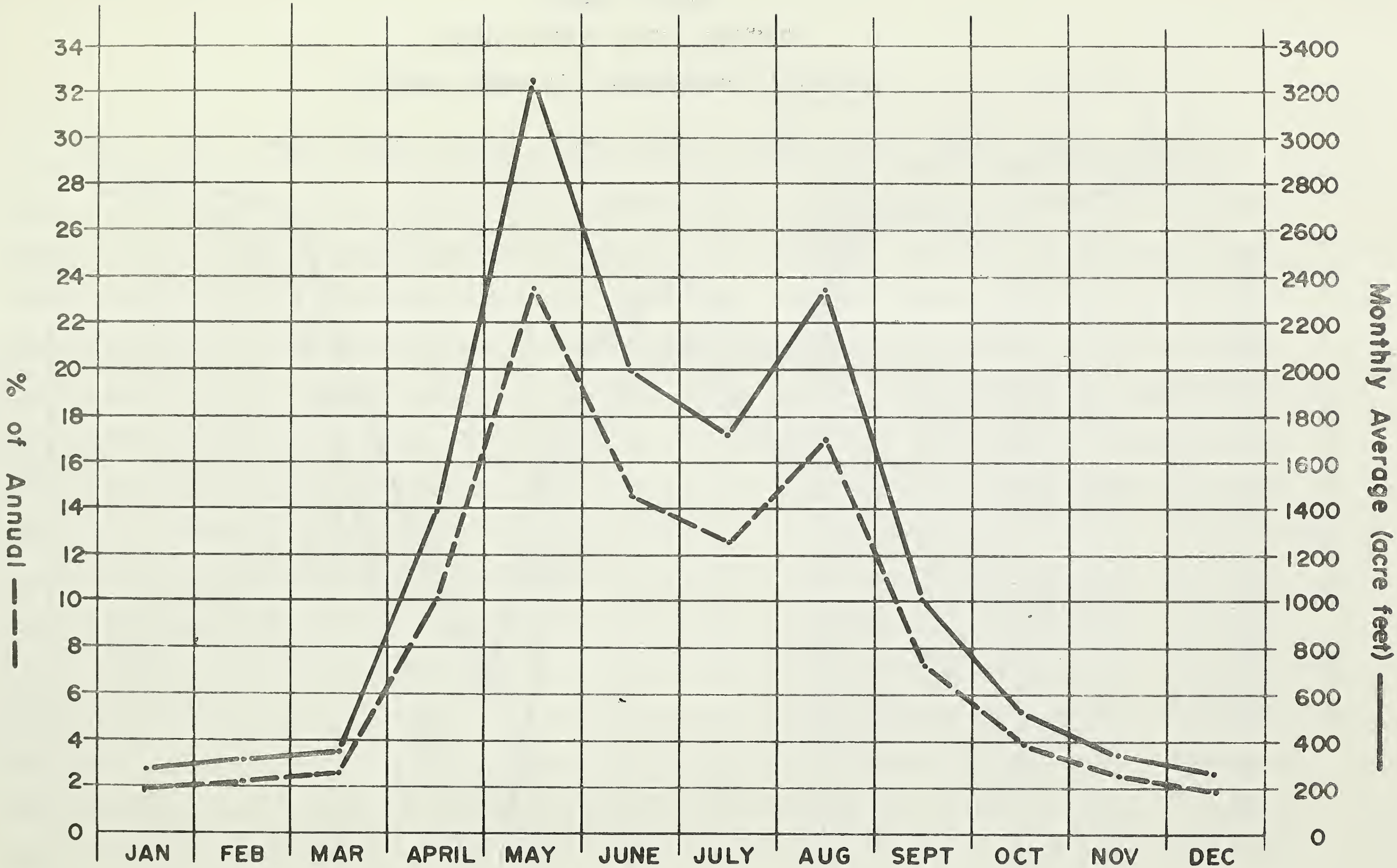
The northwestern portion of the basin is mountainous and contributes runoff to the Canadian River. The following drainages, Chico Rico, Una De Gato, Vermejo, Ponil, Cimarron, Rayado, and Mora, all show the peak runoff is from spring snow melt. The remainder of the drainages, Conchas, Ute-La Cinta, and Trementino, are in plains country, and the summer rainstorms influence the runoff pattern. This is also true of the drainages on the east side of the basin in the Dry Cimarron, North Canadian, Perico, Carrizo, Major Long, and Frio Draw.

Runoff in the main stem of the Canadian above Conchas Reservoir is influenced by both spring snow melt and summer rainstorms and has two peaks. The larger peak in the spring is from snow melt, and a second, but smaller peak occurs in the summer during the summer rainstorm season.



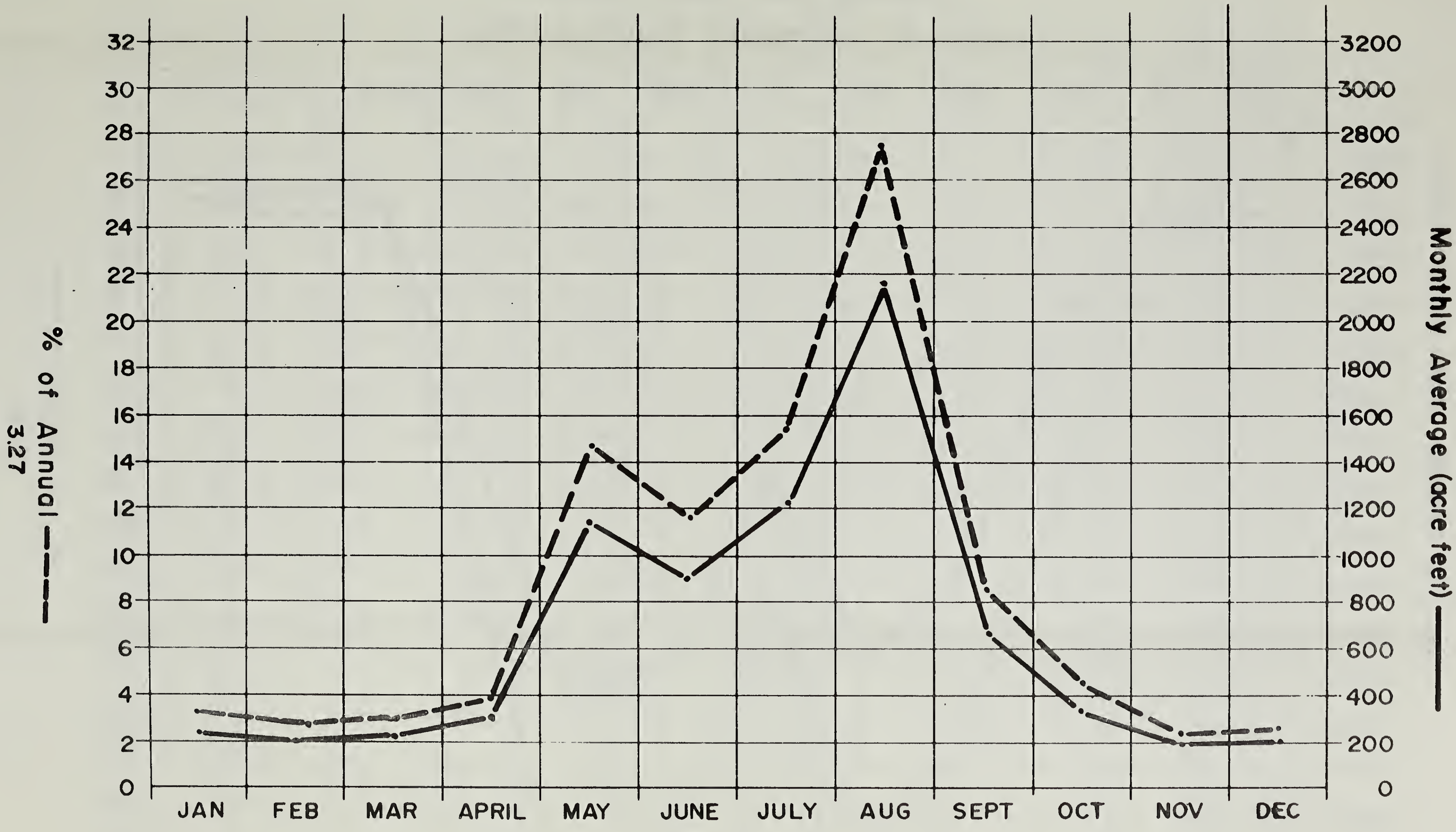
Typical Monthly Distribution of Runoff
Ponil Creek near Cimarron
1951—1970

Fig. 3-1



Typical Monthly Distribution of Runoff
Vermejo River near Dawson
1927–1970

Fig. 3-2

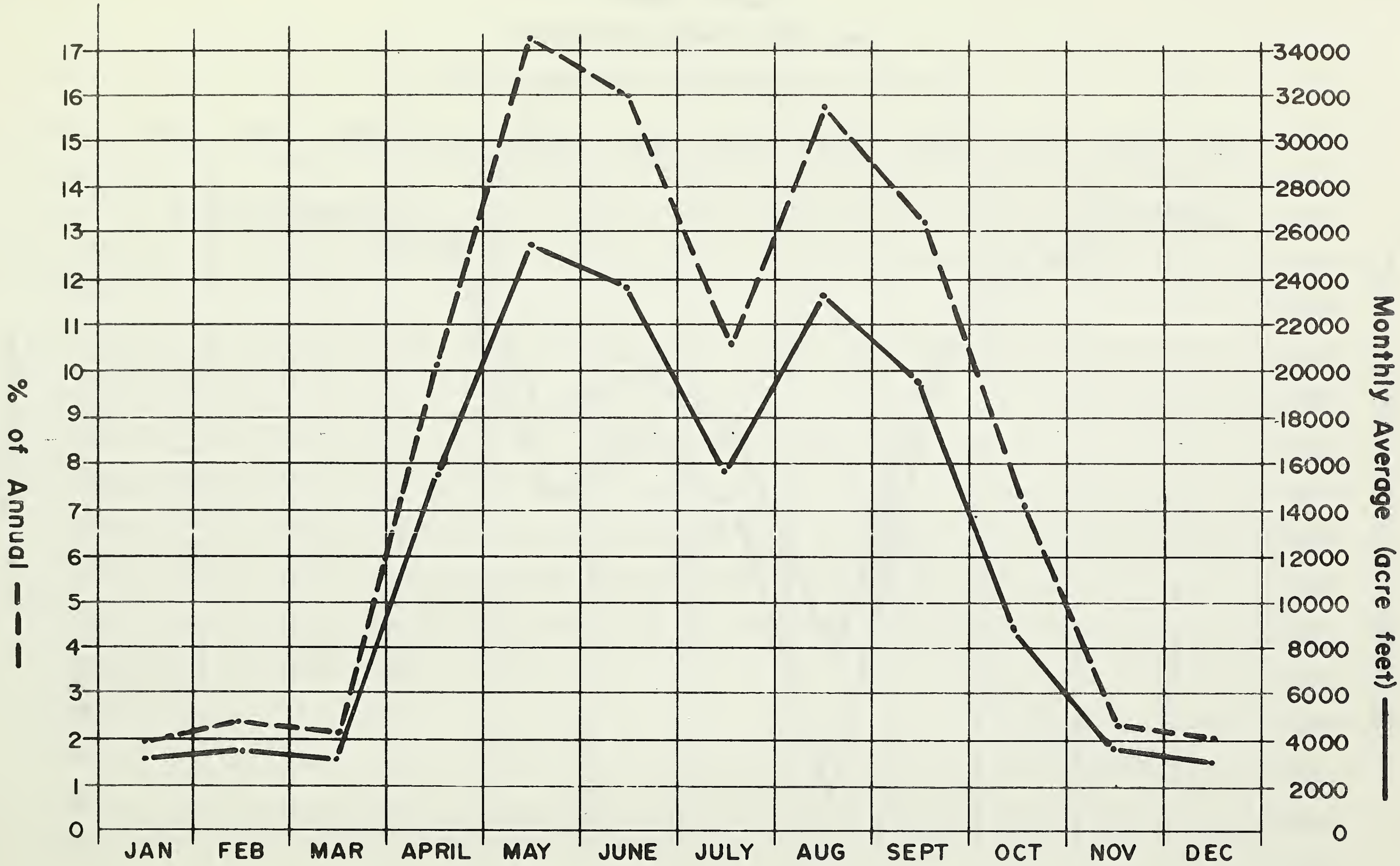


Typical Monthly Distribution of Runoff

Cimarron River near Guy

1943—1970

Fig. 3-3



Typical Monthly Distribution of Runoff
Canadian River near Sanchez
1936 — 1970

Fig. 3-4

GROUND WATER

The ground water is obtained from two possible sources: the first is bedrock aquifers, which provide the greatest areal extent and volume of storage. The second is the shallow alluvial (water deposited valley fill) material deposited along the streams and rivers. Water is also obtained from the porous and fractured volcanic flow material, which is considered a bedrock aquifer.

The bedrock aquifers vary in age from Triassic to Quaternary, and have yields of less than one gallon per minute to over 1,800 gallons per minute. The bedrock aquifer with the greatest lateral extent is the Dakota-Purgatoire of early Cretaceous Age.

The Cretaceous rocks have been removed by erosion in much of San Miguel, Quay, and Harding Counties. In these areas the Jurassic and Triassic Age rocks provide water for municipal, domestic, and livestock use.

The Pliocene Age, Ogallala Formation overlies Triassic, Jurassic, and Cretaceous Age rocks in Union, Quay, and Curry Counties. Where the Ogallala is present in thick sections, it can provide large quantities of water. If the Ogallala Formation and sandstones of the Dakota Group and Morrison Formation are in contact, large yields of water may be available. Wells from the Ogallala Formation can yield up to 1,500 gallons per minute.

Recharge of the bedrock material is generally from direct precipitation. The water on the surface percolates downward into the bedrock. The rate of recharge for the Ogallala Formation is estimated to be about half an inch per year. Ground water withdrawal in irrigated areas along the east side of the basin presently exceeds recharge.

The alluvial materials deposited along stream valleys provide a source of water for domestic and livestock use. In general, yields are small and storage in the alluvium is limited. Some alluvial areas, such as those along the Mora River near Mora, have potential for irrigation development.

The volcanic flow rocks in the Capulin area have several high-yielding wells. More study is needed to determine if the area is capable of yielding enough ground water for sustained irrigation.

Estimated recoverable ground water is about 75 million acre-feet of fresh water (0-1000 mg/l total dissolved solids) and 160 million acre-feet of saline water (1000 - 3000 mg/l total dissolved solids).

There are forty-six communities, including Philmont Scout Ranch, which have municipal water systems. Of these, forty-one obtain their entire water supply from ground water, and one uses surface and ground water.

The total withdrawal of ground water in the basin in 1975 was 156,600 acre-feet. Irrigated agriculture was the major user, withdrawing about 149,900 acre-feet., Livestock water withdrew 2,700 acre-feet. Domestic water use was 3,500 acre-feet with urban use accounting for 2,300 acre-feet of that. Manufacturing, mineral extraction, power and recreation withdrew the remaining 500 acre-feet.

The General Depth to Ground water map, indicates areas where ground water may be encountered at depths of less than 200 feet and 200 to 500 feet. This map should not be used for specific well locations. It is a generalized guide of what is in the basin relative to ground water availability.

SURFACE WATER QUALITY

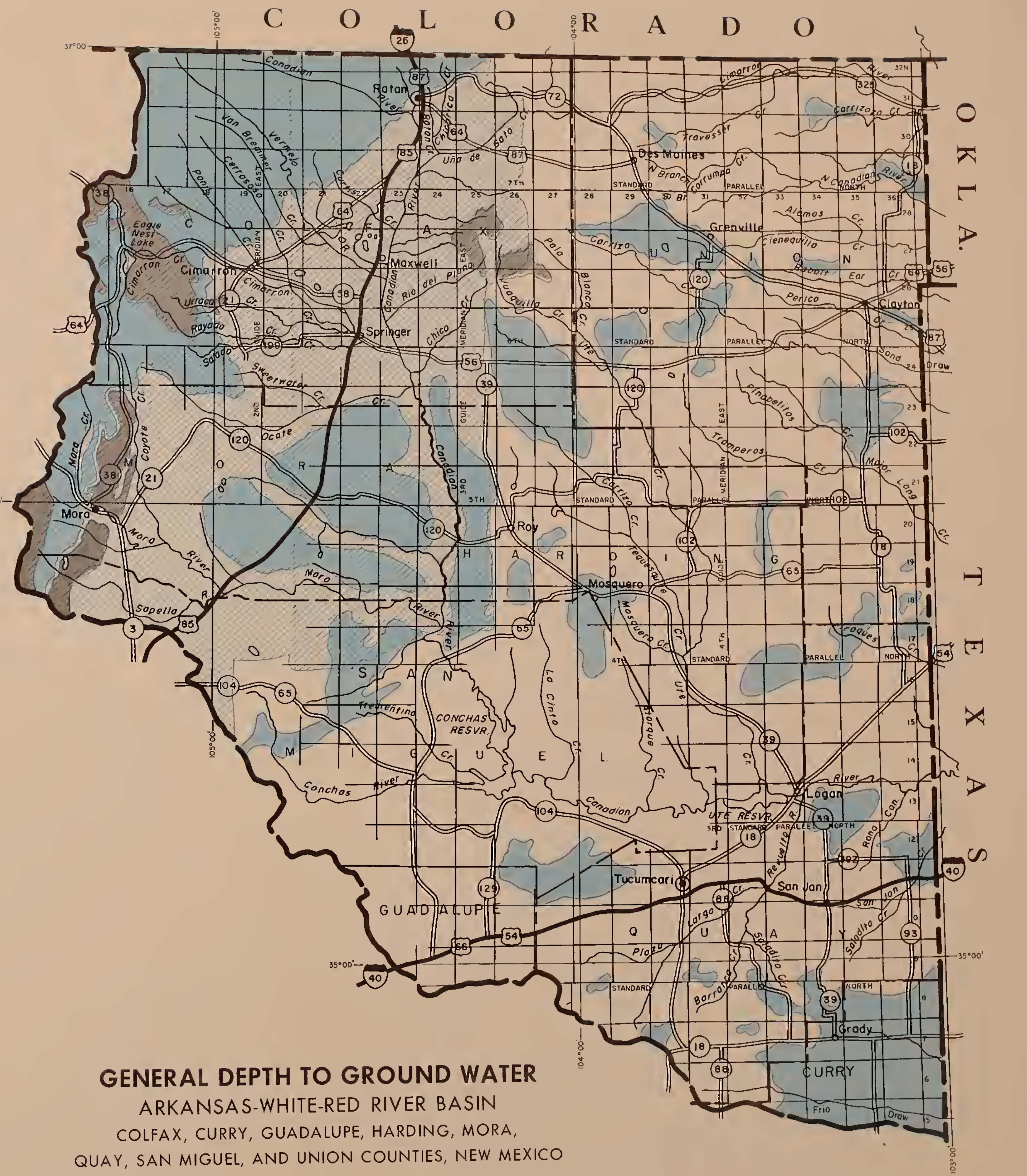
Surface water is used mainly for irrigation and recreation. Some communities use surface water storage for community water. Livestock water is provided by surface water storage mainly from stock water pits. Most industries using surface water receive it through the communities in which they are located. Some recreation is provided by lakes and perennial streams. With these various uses there are a variety of water quality conditions which either limit the use or increase the cost of water use.

The concentration of most quality indicators are at the highest levels during low flow periods. One exception is sediment which reaches its highest concentration during high flows. Two sampling stations on the Canadian River are particularly notable because of their poor water quality. One is near Taylor Springs in Colfax County and the other is just upstream from the New Mexico-Texas state line. These areas have been monitored since 1969.

At Taylor Springs, conductivity has been as high as 4,000 micromhos, with a mean of 2,500 mg/l. for 167 samples. Turbidity has a mean of 300 JTU's, with a high of 11,600 JTU's. Suspended sediment at this point has varied from 0 to more than 36,400 tons per day. Flows during this same period varied between 1.6 to 1,400 cubic feet per second.

The state line sampling station has conductivity which varies from 580 to 12,500 micromhos, with a mean of 5,470 micromhos. Total dissolved solids vary from 357 to 7,240 mg/l. with a mean of 3,256 mg/l. Measured sediment discharge has been as high as 158,000 tons per day. Flows during the same period varied between 0 and 1000 cubic feet per second.

Data on coliform bacteria tests are limited in number throughout the basin. Samples collected from Ute Lake indicate mean values of fecal coliform varying from 1.1/100 ml to 15/100 ml from various sampling stations. Summary of total coliforms in five lakes in Colfax County are shown in Table 3-8.



GENERAL DEPTH TO GROUND WATER

Less than 200 feet

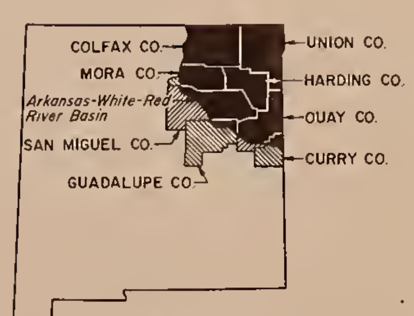
200 to 500 feet

Areas of Outcrop

Declared Underground Water Basin

EXPLANATION:

Areas of outcrop of granite, quartzite rhyolite, large masses of intrusive rocks, and metamorphosed sedimentary rocks. The water table in these areas is likely to be discontinuous. Locally the rocks are dry. Limited quantities of water are present, locally where the rocks are fractured or weathered, and in sand and gravel deposits of major stream valleys. The depth to water, where water is present, is commonly less than 100 feet below the land surface.



LOCATION MAP

GENERAL DEPTH TO GROUND WATER

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, WTSC Cartographic Unit from USGS 1:1,000,000 National Atlas. Thematic detail compiled by State Staff from USGS, New Mexico state water plan general depth to groundwater in New Mexico, 1971.

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TABLE 3-8. - SUMMARY OF COLIFORM* RESULTS OVER THE YEAR 1978, COLFAX COUNTY LAKES, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Lake	Community Served	Raw Water Coliform Count	Treated Water Coliform
Cimarroncito Reservoir	Cimarron	Seasonally TNTC**	.1-3/100 mls seasonal high***
Eagle Nest Lake	Springer-via the Cimarron River	Seasonally TNTC	Rarely rated-0 throughout '78
Miami Lake	Miami	Confluent growth throughout the year, seasonal increases to millions	1-3 after treatment especially in warmer months
Lake Malaya	Raton	16/100 ml occas. seasonal increase	0 throughout '78
Charette Lake	Recreational Use	Confluent growth throughout the year	Water used not treated-well nearby averages 1/100 ml.

Source: Environment Improvement Division, Raton Field Office

* Coliform - includes fecal coliform bacteria. Not all coliforms are of fecal origin.

** TNTC - Bacteria too numerous to count can indicate counts in the millions.

*** We have large seasonal variations due to algae blooms and lake turnover. Coliforms in general are present year-round in all our lake sources.

Four communities, Raton, Cimarron, Miami, and Springer, use surface storage for all or most of their water needs. None of the lakes are located where they are particularly susceptible to agricultural chemicals. Raton and Cimarron have relatively well-protected drainage areas which consist principally of woodlands. Miami Lake receives most of its water from Rayado Creek. Springer Municipal Lake water is diverted from the Cimarron River near the CS Ranch headquarters.

PHOTO 3-13. Some communities' water supply is provided by storage in surface reservoirs.

For domestic use, the water is well within the permissible criteria for most parameters. The water is moderately hard to hard (61 to 180 mg/l of calcium carbonate). Turbidity in the municipal water reservoirs can be quite high, depending on the season. New Mexico sets a turbidity limit of 5 JTU's for domestic use. Samples from Lake Maloya, which is the water supply storage reservoir for Raton, have had as much as 36 JTU (Environmental Improvement Agency, Major Communities, 1974).

Ute Reservoir is presently used for recreation. Plans for piping water from Ute Reservoir to communities for municipal use are being evaluated by the Bureau of Reclamation. The Ute Reservoir water for municipal use would be moderately hard to hard and is near maximum recommended limits for total dissolved solids. Other parameters would generally meet criteria for domestic water use set forth by the New Mexico Environmental Improvement Agency.

The water stored in Conchas and Eagle Nest is primarily for irrigation. Conductivity levels and total dissolved soilds concentration of the water from Conchas Reservoir would indicate a potential for salt problems on poorly drained soils. In general though, the water is suitable for use for irrigating most soils.

GROUND WATER QUALITY

Ground water is used for municipal, industrial, domestic, livestock, and irrigation. The quality of the ground water varies from area to area and could limit the use of the water.

Forty-two communities obtain water from ground-water sources.

In general, the water quality is fairly good, with few instances of poor quality water. The water is generally hard throughout the basin but total dissolved solids are generally below the maximum limits recommended by the Water Supply Regulation Section of the New Mexico Environmental Improvement Agency (Environmental Improvement Agency, Minor Communities, 1974).

Colfax County has seven communities obtaining water from ground water. The water is generally within the recommended limits for various chemical elements or other pollutants, but some individual wells exceed certain limits. The water is generally hard. One well is high in lead; another exceeds the criteria for turbidity, (New Mexico Environmental Improvement Division) total dissolved residues, fluoride, and iron. Several wells exceed the arsenic limit.

In Curry County, Grady is the only municipal water system within the AWR River Basin. The water is relatively hard and exceeds the fluoride limits. It is also high in nickel and selenium.

Guadalupe County has no community water systems within the AWR River Basin.

Harding County has three community water systems using ground water. The limited data available indicate the water is relatively hard and exceeds the maximum levels for fluoride.

Mora County has 18 community water systems using ground water. The water quality is generally fair to good. Some wells are high in fluoride, total dissolved residue, conductance, sodium, and/or selenium. The Upper Holman municipal well exceeds the criteria for sodium, total dissolved residue, conductance, and has more than double the barium level recommended.

Quay County has four municipal water systems. The quality is generally good for municipal use. Over most of the county the water is hard, but other parameters are within acceptable limits. The San Jon wells are the exception to this. Test data from four of the San Jon municipal wells indicate the water is soft but exceeds the maximum limits for sodium, fluoride, bicarbonate, alkalinity, total dissolved residue, and pH. Three of the wells exceed the limits for arsenic.

TABLE 3-9 - QUALITY OF SELECTED COMMUNITY WATER SUPPLY WELLS
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	U.S. Public Health Service Standards	Angel Fire Colfax Co. Lake Well Well #3	Clayton Union Co. Clayton Well #4	Eagle Nest Colfax Co. Eagle Nest Well #1	Grady Curry Co. Grady Well	Maxwell Colfax Co. Maxwell Well Field	Mora Mora Co. Mora Well #1	Roy Harding Co. Roy Well #1	San Jon Quay Co. San Jon	Tucumcari Quay Co. Tucumcari Well #7	Wagon Mound Colfax Co. Wagon Mound Well #1
		319	270	318	274	264	162	269	279	280	166
Latitude		36-21-15	36-26-55	36-33-00	34-49-27	36-32-04	35-58-18	35-54-05	35-07-17	35-08-44	36-00-51
Longtitude		105-17-43	103-11-08	105-15-30	103-19-00	104-25-42	105-19-42	104-05-01	103-19-58	103-48-00	104-42-35
						Composite Sample					
Sodium	1/	13.80	18.40	6.00	39.10	35.20	4.60	25.30	418.60	118.20	25.30
Potassium	1/	0.78	3.90	0.78	0.43	15.60	0.39	2.57	2.34	4.29	2.34
Calcium	1/	73.00	43.20	33.00	31.00	96.00	56.00	48.00	4.00	88.40	40.00
Magnesium	1/	13.40	17.60	9.20	17.70	12.20	7.00	21.90	1.80	8.50	27.70
Iron-Total	0.3	0.25	0.25	0.30	0.00	0.25	0.25	0.12	0.25	0.10	0.25
Manganese	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Chloride	250	5.60	8.80	4.00	11.80	21.20	1.80	13.00	78.40	47.90	8.60
Fluoride	2/	0.21	0.82	0.10	3.70	0.34	0.10	1.80	3.10	1.10	0.38
Nitrate	45	0.40	4.12	0.40	9.20	11.30	2.34	4.40	5.25	0.05	3.77
Bicarbonate	1/	304.50	228.60	126.90	215.30	227.40	173.70	208.60	707.40	338.20	283.30
Carbonate	1/	None	None	None	None	None	None	None	34.20	None	None
Sulfate	250	7.40	21.40	13.40	24.00	134.80	30.50	60.00	110.00	130.00	18.60
Phosphate	1/	-	-	-	-	-	-	-	-	-	-
Total Hardness	1/	237.50	180.00	120.00	150.00	290.00	168.00	210.00	17.50	256.00	214.00
Alkalinity	30 but 500	249.60	187.00	104.00	176.50	186.00	142.00	171.00	607.80	277.00	232.00
Total Dissolved Residue	1/	295.00	295.00	158.00	0.270	475.00	245.00	305.00	1,330.00	600.00	340.00
Surfactants	0.5 for ABS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05
pH	6.0to8.5 range	7.46	7.89	8.18	8.20	8.1	7.95	7.90	8.74	7.52	8.11
Odor	15 Units	Negative	None	None	Odorless	None	None	Normal	None	None	None
Color	3 Units	Negative	None	None	Colorless	None	None	Clear	None	None	None
Turbidity	5 Units	1.00	0.50	0.30	0.04	0.20	0.30	0.03	1.00	1.80	0.20
Conductance Micromhos/ cm 25°C	1,000	463.00	412.00	227.00	435.00	676.00	329.00	540.00	1,701.00	855.00	468.00
Arsenic	0.01	0.010	0.010	0.040	0.040	0.040	-		0.050	0.010	0.010
Barium	1.0	1.000	Negative	1.000	0.100	Negative	Negative	Data Not	1.000	0.500	Negative
Boron	1.0	0.250	0.250	0.300	0.050	0.250	0.250		0.600	0.250	0.250
Cadmium	0.01	0.010	Negative	0.010	0.010	Negative	-		0.010	0.010	Negative
Chromium	0.05	0.030	Negative	0.050	0.010	Negative	Negative		0.010	0.050	Negative
Copper	3.0	0.050	0.400	0.050	0.025	Negative	-		0.025	0.025	0.070
Cyanide	0.01	-	-	-	-	-	-		-	-	-
Lead	0.05	0.010	Negative	0.050	0.015	0.010	-		0.010	0.010	Negative
Mercury	0.005	-	-	-	0.0005	-	-		-	-	-
Molybedenum	0.01 5/	-	-	-	-	-	-	Available	-	-	-
Nickel	0.05 5/	0.100	Negative	0.100	0.100	Negative	Negative		0.100	0.100	Negative
Silver	0.05	0.050	Negative	0.050	0.050	Negative	Negative		-	0.010	Negative
Selenium	0.01	0.020	Negative	0.010	0.030	Negative	Negative		0.030	0.025	Negative
Zinc	5.0	0.300	Negative	0.800	0.050	Negative	-		0.025	-	Negative
Radium 226	3uuc	-	-	-	-	-	-		-	-	-
Strontium	10uuc	-	-	-	-	-	-		-	-	-
Gross Beta	1000uuc 4/	-	-	-	-	-	-		-	-	-

1/ No standard set.
2/ Flouride limits vary-For discussion refer to text of publication listed in footnote 3.
3/ New Mexico Public Water Supplies Chemical Data, 1974, prepared by the New Mexico Environmental Improvement Agency Water Supply Regulation Section.
4/ In absence of Strontium 90 and alpha emiters.
5/ State limit.

San Miguel has two community water systems which use ground water. Both systems are generally good, with no parameters exceeding the recommended limits.

Union County has four community water systems using ground water. The water is hard, but good in other parameters.

Most of the farms, ranches, and small communities not served by a community water system derive their water from ground water. The water is generally hard, but useable for domestic purposes. Many wells exceed the recommended limits for certain chemicals, but in most cases it is the only water available.

Ground water is suitable for livestock use, although some water will exceed parameters for arsenic, cadmium, chromium, fluorine, lead, and selenium. (Committee on Water Quality Criteria et al, 1972)

The suitability of water for irrigation depends on the inter-relation of soils, climate, plant tolerance, and management practices. Water with relatively high salinity can be used on soils with good drainage and permeability under good management practices. Fine-grain soils which are flocculated will disburse and become impermeable under irrigation with water having high sodium (Na).

Semi-arid areas have some specific irrigation problems. Soils are not usually as well developed and may have high amounts of salt. In general, the salinity hazard may be a problem where total dissolved solids in the water exceed 500 mg/l. Below 500 mg/l., there is normally no noticeable effect to crops from the irrigation water. Above 500 mg/l., depending on crop tolerances, there may be detrimental effects.

High concentrations of dissolved solids are not presently a problem in irrigated areas of the basin. With any introduction of new sources of water for irrigation in the semi-arid basin, the salinity problem should be investigated.

There is a permeability hazard associated with the SAR (sodium absorption ratio) (Committee on Water Quality Criteria et al, 1972) and bicarbonate hazard. The SAR may cause damage to the plants if it exceeds four. The main problem with high sodium is the reduction of permeability of the soil because of the excess sodium. Several irrigation wells in Quay County have water with SAR exceeding 5, and two wells drawing from the Jurassic Age, Entrada Formation, have SAR's of 24 and 38. Water management practices and suitable soils are needed with this water for successful crop production under irrigation.

Generally the water used for irrigation is from the Pliocene Age Ogallala Formation and is suitable for irrigation.

WATER USE

Many uses are made of the surface water at the present and about 202,000 acre-feet are depleted annually. These uses are urban, rural, manufacturing, minerals, power, irrigation, recreation, fish and wildlife, and livestock. Surface water depletions are shown in Table 3-6. At present, about 84.5 percent of the total surface water supply available for depletion is being depleted. About 63,450 acre-feet, or 31.4 percent of the depletions, are evaporation from stock ponds and reservoir water surfaces.

Irrigation of crops is the largest use of water and depletes 117,260 acre-feet per year, or about 58 percent of identifiable depletions. This is about 49 percent of the total surface water available for depletion.

F I S H A N D W I L D L I F E

MAMMALS

Major game animals are elk, mule deer, pronghorn antelope, Rocky Mountain bighorn sheep, Barbary sheep, Siberian ibex, black bear, and mountain lion. At the present time there is public hunting for all species except the bighorn sheep and Siberian ibex. See Distribution of Big Game map.

The diverse plant communities of the AWR Basin provide habitats for a wide variety of nongame mammals. The higher, forested mountains contain shrews, chipmunks, Abert's squirrel, yellow-bellied marmots and martin. Mid-elevation pinyon pine woodlands and oak brush communities contain cottontail, rock squirrel, woodrat, porcupine, gray fox and bobcat. The broad expanses of short and midgrass plains contain jack rabbit, badger, prairie dog, ground squirrel, pocket gopher and striped skunk.

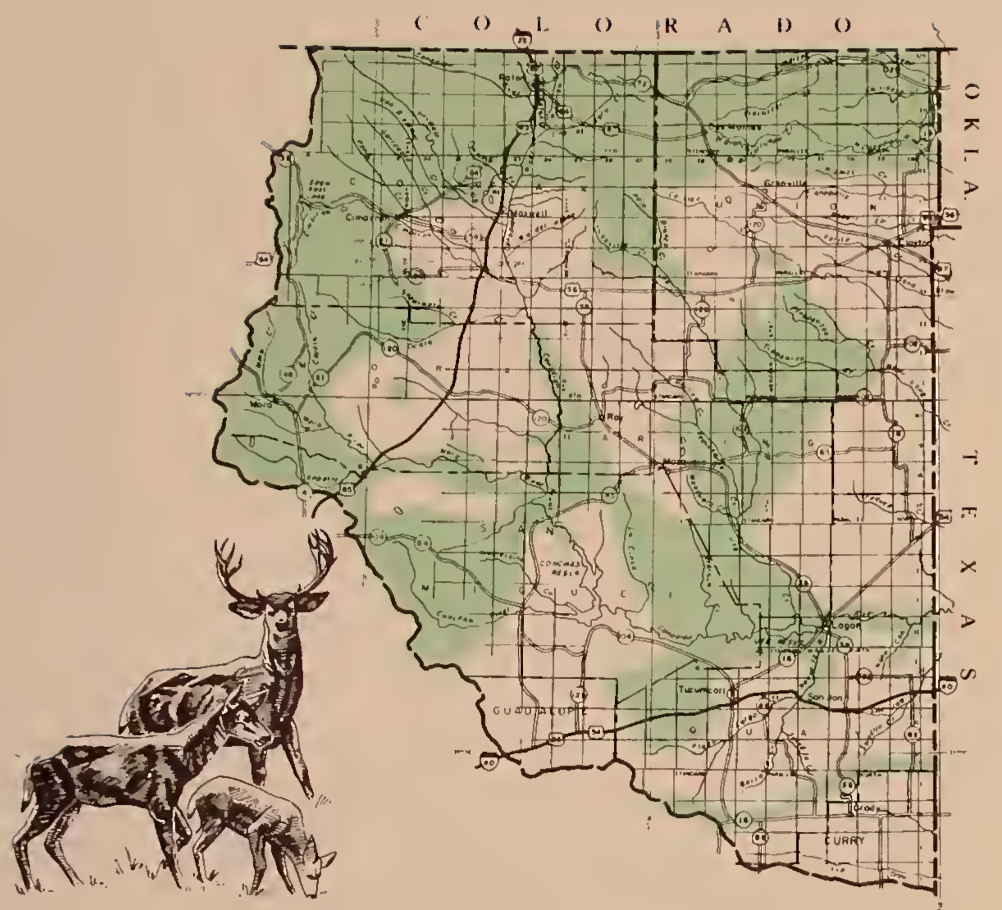
Occurrence

Data collected by the New Mexico Department of Game and Fish for game management units (See Game Management Unit Map), and adjusted to conform to the basin boundaries, indicate current populations as shown in Table 3-10.

Endangered Mammal Species

The black-footed ferret is an uncommon species which lives in association with priarie dog towns. The ferret has not been verified as presently occurring within the basin, although it has in the past. This species is included in the Federal Endangered Species list.

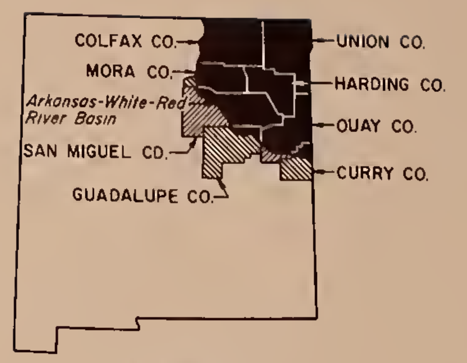
The New Mexico Wildlife Conservation Act of 1974 lists the river otter, mink, martin and black-footed ferret as Endangered Species. The river otter and ferret are considered in jeopardy of survival; while the mink and martin may become in jeopardy in the foreseeable future.



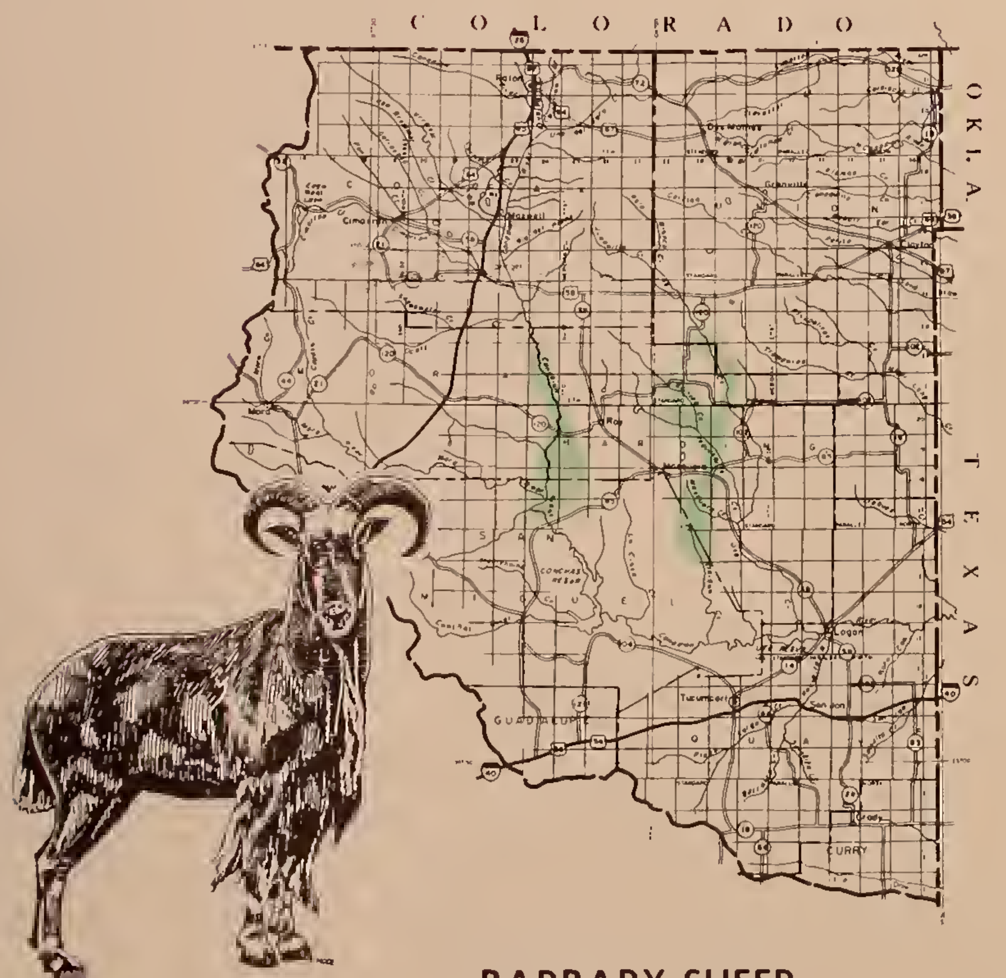
MULE DEER

ELK

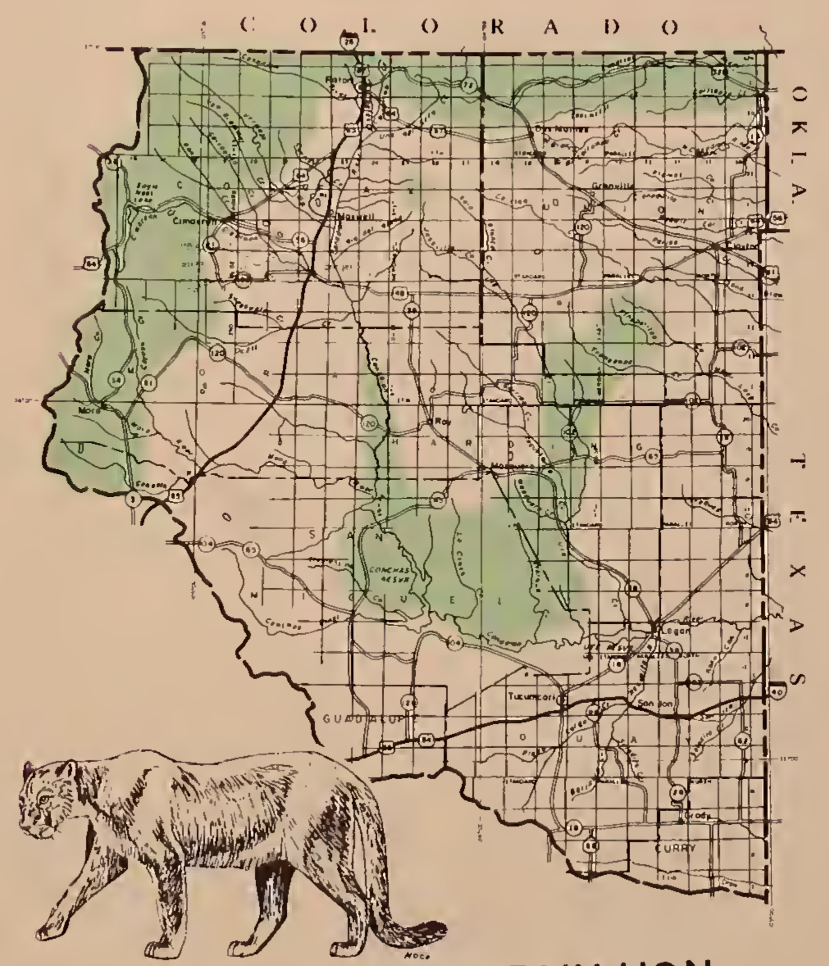
PRONGHORN ANTELOPE



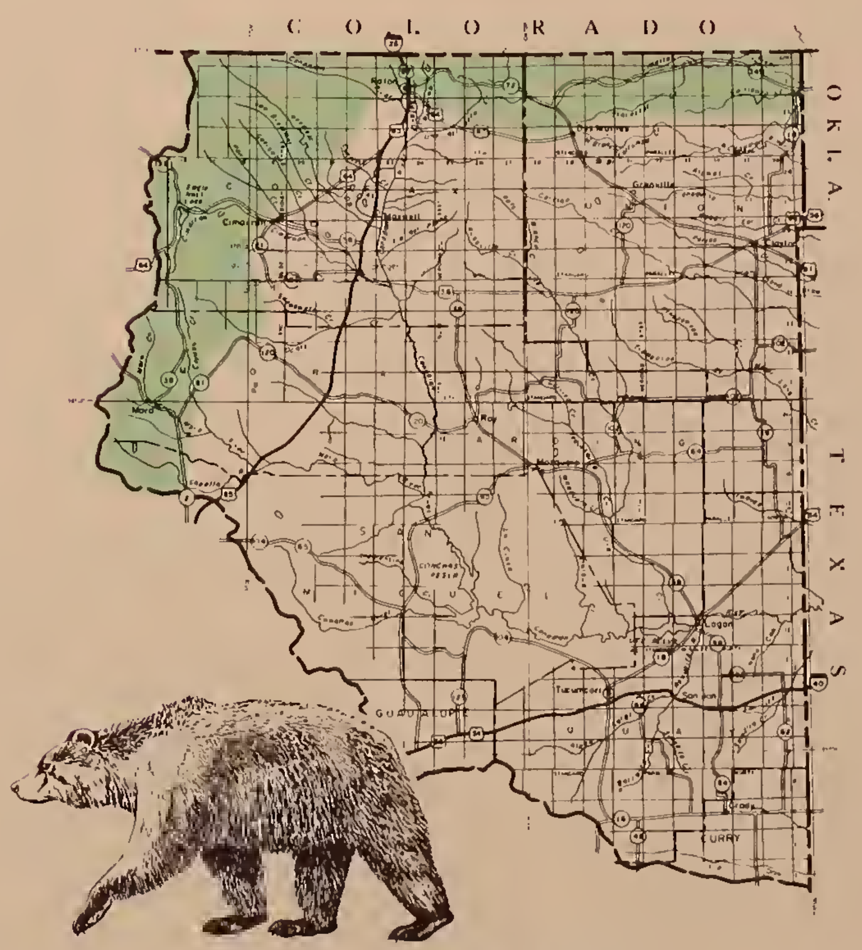
LOCATION MAP



BARBARY SHEEP



MOUNTAIN LION



BLACK BEAR

DISTRIBUTION OF BIG GAME

ARKANSAS-WHITE-RED RIVER BASIN

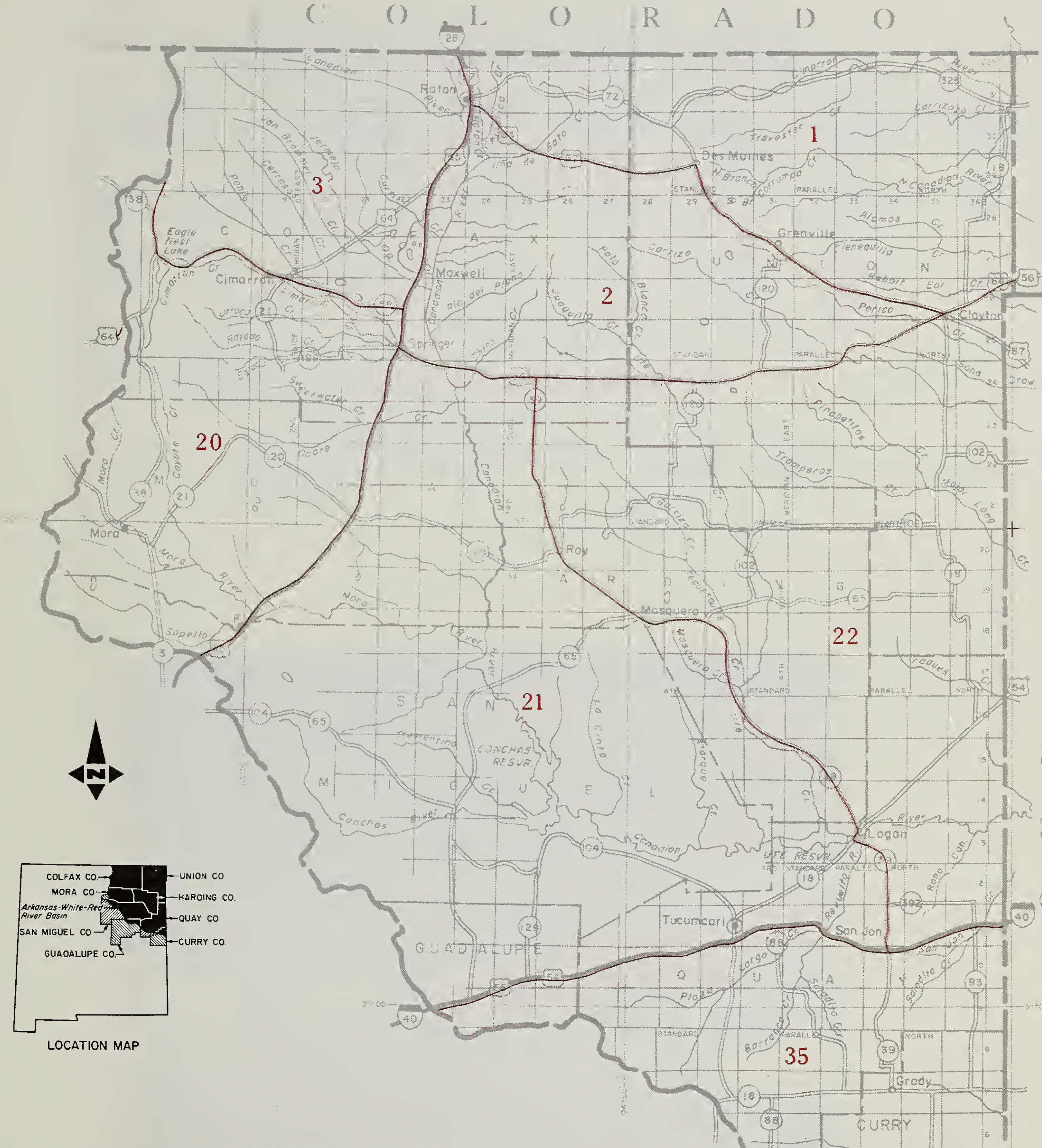
COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

MAY 1976

20 0 20 40 MILES
SCALE IN MILES

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:1,000,000 Nat. Atlas.
Thematic detail compiled by state staff.
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1979

M7-N-22828-17



GAME MANAGEMENT UNITS

New Mexico Department of Game and Fish

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,500,000

LEGEND

20 Unit Number

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-PL-22828-26

TABLE 3-10 - ESTIMATED GAME ANIMAL POPULATIONS - 1975
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Animal	Colfax	Union	Harding	Mora	San Miguel*	Quay*
Mule deer	22,000	6,500	2,300	2,400	1,600	850
Elk	13,000	100		570	200	
Pronghorn antelope	3,360	8,400	1,200	1,880	1,200	400
Bighorn sheep	6					
Barbary sheep			190	160	290	
Turkey	4,850	2,300	400	1,520	1,125	50
Bear	200	40	40	180	130	
Mountain lion	230	50	30	95	120	10
Siberian ibex **						

Source: New Mexico Game and Fish Department

* That portion in the basin

** Forty animals were released in 1976. Current population estimates are not available.

PHOTO 3-14. Pronghorn Antelope - A common big-game animal of the open rangeland.

Management

The management of habitat for those big game animals which graze or browse is directly related to the livestock and timber industries. There is relatively little land area which is being managed primarily as wildlife habitat. Included are the 33,116-acre Colin Neblett and the 5,415-acre Elliot Barker Wildlife Areas which are owned by the Game and Fish Department.

Occurring as a wide arc, swinging southwest from Raton to Black Lake, there are almost three-quarters of a million acres of privately-owned lands on which wildlife habitat receives some management consideration. The National Rifle Association acquired land in 1974 which will be managed for outdoor recreation and wildlife habitat. The adjacent Vermejo Park lands, while primarily managed for livestock and timber, are also managed for big game. The Philmont Scout Ranch and the UU Ranch also manage primarily for livestock, but place some emphasis upon big game.

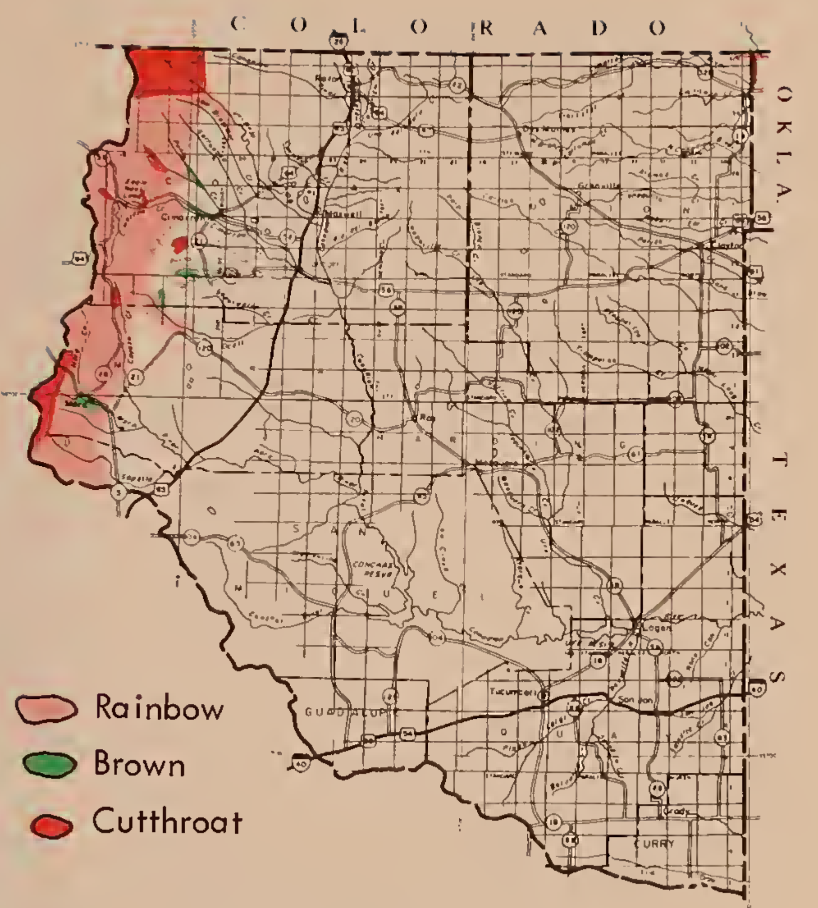
The amount of management consideration given to maintaining or improving big game habitats on private lands varies widely. Those landowners who have strong personal interests, or who realize income from big game hunting, tend to give wildlife habitat some consideration in the management of their lands. Many landowners appear to rely entirely on the number of big game harvested as the only necessary management technique. And, of course, mention must be made of those persons who consider big game a personal liability because of forage utilization or problems with hunters.

The future quality of big game habitats within the basin is dependent upon the economic well-being of the rancher and timber owner and his conservation viewpoint. If the landowner allows overexploitation of his vegetative resources by cattle or chainsaw, then dependent wildlife must move on or die. Under systems of sound conservation, the management of resources will provide for adequate economic returns and stability in the resource base while sustaining wildlife on quality habitats.

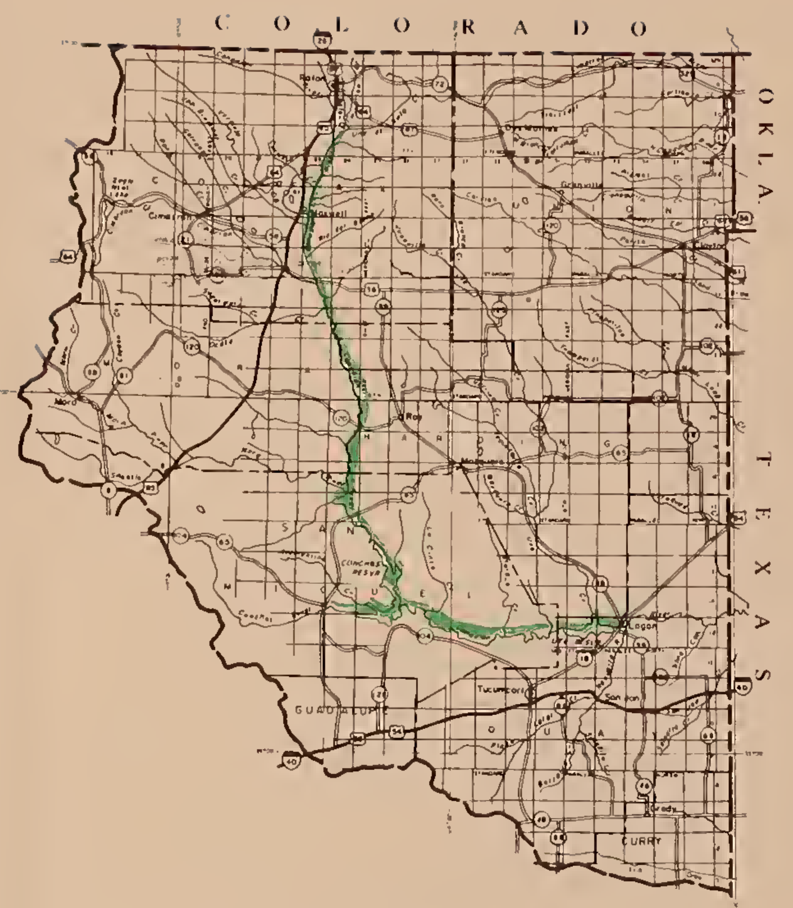
FISH AND FISH HABITAT

Lakes furnish the bulk of the fish habitat within the basin. Of the approximately 21,000 maximum pool surface acres of lakes, about 5,200 acres support trout fisheries. Above 7,000 foot elevation, all lakes that do not winter-kill can be considered suitable for trout management. These lakes receive runoff almost directly from melting snowpack. The lakes are cold and relatively infertile, which, coupled with the short growing season, limits fish productivity.

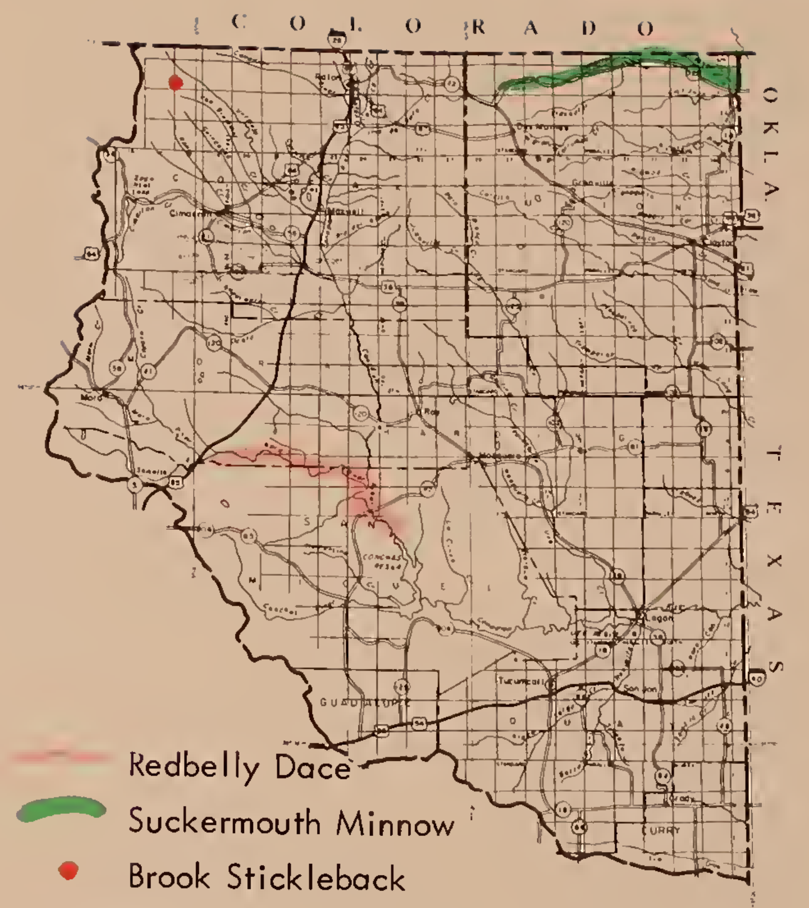
Lakes which are capable of supporting warm water fish populations occur at lower elevations as either natural basin lakes or artificial impoundments on the major rivers. Most of the natural basin lakes have relatively small watersheds and fluctuate so widely in water level that they are mostly unsuitable for fishery management.



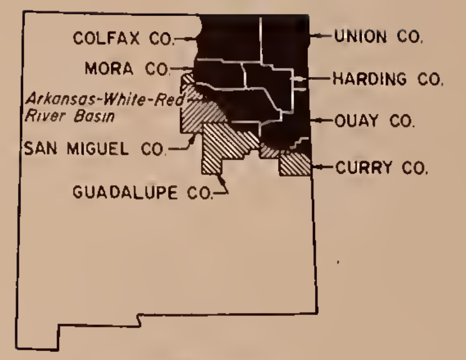
DISTRIBUTION OF TROUT



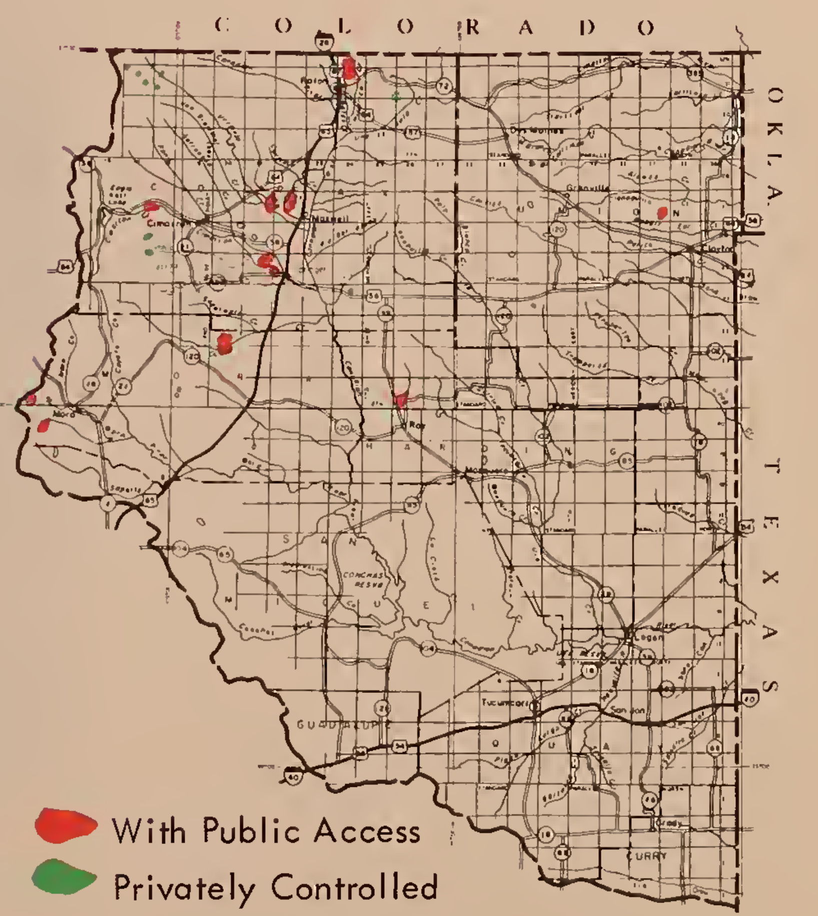
DISTRIBUTION OF CHANNEL CATFISH



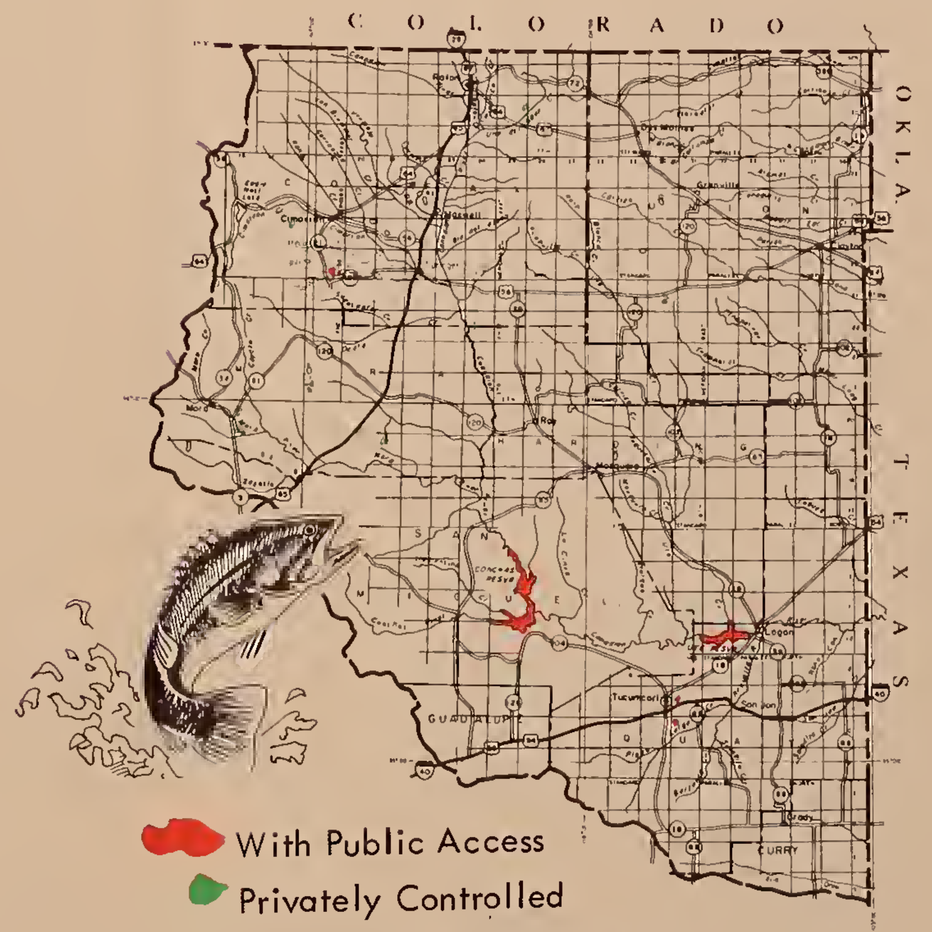
DISTRIBUTION OF RARE FISH SPECIES



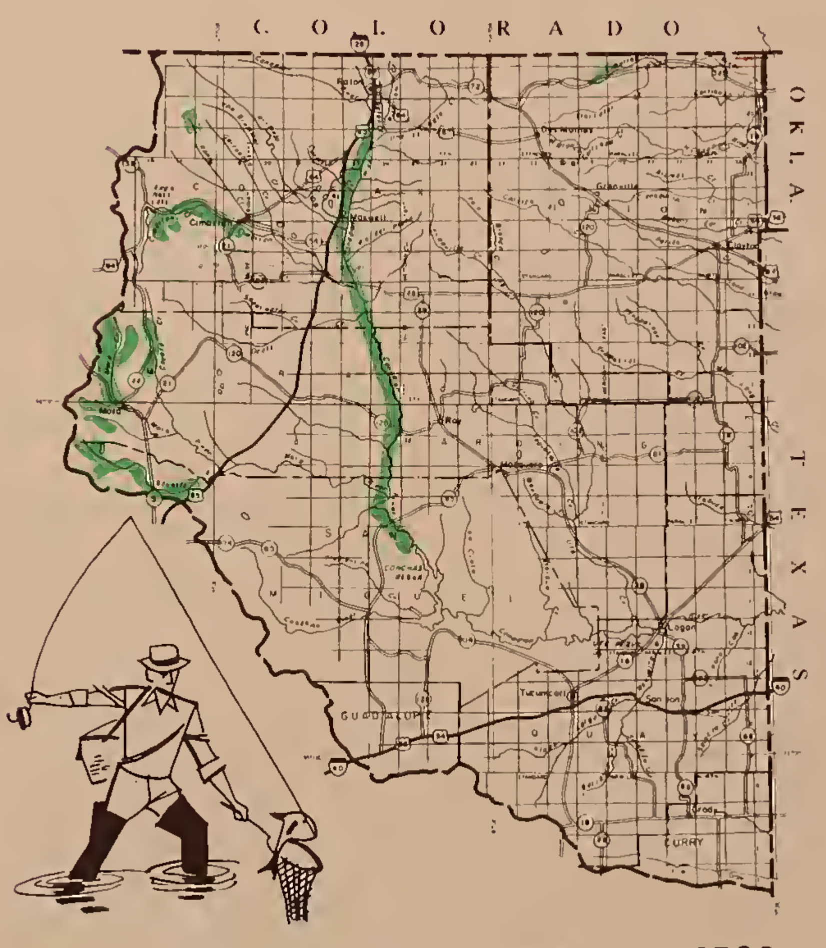
LOCATION MAP



COLD WATER LAKES



WARM WATER LAKES



STREAMS WITH PUBLIC ACCESS

DISTRIBUTION OF FISH AND FISH HABITAT

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

MAY 1976

20 0 20 40 MILES
SCALE IN MILES

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:1,000,000 Nat. Atlas.
Thematic detail compiled by state staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR 1979

M7-N-22828-18

The large, main impoundments, such as Conchas and Ute Lakes, are warm and fertile and produce large populations of adapted fish.

There are approximately 3,600 acres of suitable trout lakes available for public fishing. About 1,600 acres of trout waters, principally Eagle Nest Lake, are privately controlled. Of the suitable warm water fisheries, 14,500 acres are available to the public, while about 1,200 acres are under private control.

The Arkansas-White-Red River Basin includes about 1,500 miles of streams; however, many are dry or intermittent during much of the year. It has been estimated that about 480 miles of stream are suitable for fisheries management, of which about 270 miles are capable of supporting cold water fish species. The public has access to about 170 miles of trout streams and 66 miles of warm water streams.

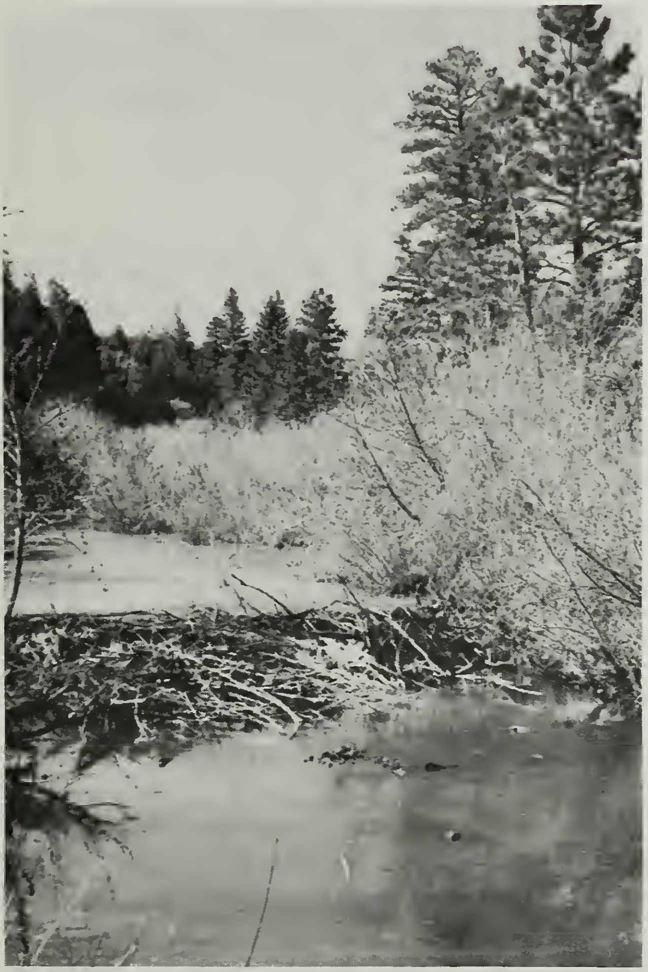


PHOTO 3-15. Cimarron Creek. Streams in higher portions of the area provide excellent habitat for trout.

Occurrence

The major associations of fish species are described in terms of habitat dependence; i.e., warm and cold waters; lake and stream.

Warm water lakes commonly support largemouth bass, crappie, bluegill, and channel catfish. The walleye and northern pike have sucessfully been introduced into several warm water lakes. Carp, carpsucker, and many minnow species are major components of these fish populations.

Cold water lakes commonly support rainbow, brook, and cutthroat trout, white sucker, and creek chub. There will usually be representatives of warm water species in lakes at lower elevations.

Warm water streams commonly support channel catfish, black bullhead, flathead chub, Arkansas river shiner, and other minnow species.

Cold water streams commonly support rainbow, brook, brown, or cutthroat trout which occur as varying mixed populations in response to habitat conditions and stocking history. These streams also support the white sucker, longnose dace, and other minnow species.

Endangered Fish Species

The report "Status of Rare Native Fish in New Mexico" (New Mexico Department of Game and Fish, 1975) indicates that no fish species appearing on the United States List of Endangered Fauna, USDI, May 1974, occur within the basin. However, the report makes the distinction of further describing those fish species for which "prospects for survival or recruitment within the state are likely to be in jeopardy within the foreseeable future." This group of fish is considered as threatened species and includes: the redbelly dace, which is described as an extremely rare minnow species occurring in a few small tributaries of the Canadian River; the Suckermouth minnow, which occurs within the basin, is described as rare; and the Brook stickleback, which is presently known to occur in New Mexico only in Merick Lake, an artifical impoundment located at 8,500 foot elevation in Vermejo Park.

Management

The production of desirable fish species and the opportunity for the public to harvest these fish is to a large degree a direct result of the aggressive management policies of the New Mexico Game and Fish Department.

A comprehensive program of stocking trout in all suitable waters which are available for public fishing has been developed over many years. The allocation of catchable-size trout is based upon a formula which considers three factors: available water area; water quality; and the history of fishing pressure. A long term program of acquisition for public access to privately owned lands and waters has also greatly increased fishing opportunity.

The introduction of walleye into Conchas Lake, Ute Lake, Stubblefield Lake, and Clayton Lake has greatly increased fishing opportunity. In a similar way, the introduction of northern pike into Miami and Springer Lakes has provided new opportunities to catch trophy fish.

Pollution related fish kills do not appear to be a significant or chronic problem within the basin. During the period 1968-1975, there were 26 investigations made statewide into potential pollution problems. Within the basin, studies were conducted on the Mora River, Vermejo Creek, and as part of a range caterpillar control program (New Mexico Game and Fish Department, March 1975). A dramatic kill of 18,500 trout occurred in the Cimarron River in October 1972 when a tank truck overturned and spilled diesel oil into the river.

The level of fishery management being applied to privately controlled waters is highly variable. Where there are commercial recreation interests, such as Eagle Nest Lake and the Vermejo Park Lakes, the operators practice fisheries management principally by stocking trout. On the other hand, most of the smaller private waters, both streams and impoundments, receive little fishery management consideration.

BIRDS

The distribution of bird communities, according to the concept of biotic province, depends upon bird-vegetation relationships and is more closely associated with vegetational life forms than with particular plant species of the community.

Within the AWR Basin, representative biomes which have characteristically associated bird communities, include the spruce-fir conifers, mixed conifers, ponderosa pine, pinyon-juniper pygmy forest, oak brush, short-grass prairie, hardwood riparian woodland, wetlands, and others. Bird species as well as bird communities reflect a continuum through these biomes, rather than being found as distinct groups.

Bird species diversity is closely related to habitat diversity. The effects of man-induced changes to natural environments are apparent in the response of bird communities. Consequently, grassland portions of the River Basin exhibit relatively small species diversity and few breeding species, a reflection of the large unbroken expanses of a single habitat type and of grazing induced vegetational monotony. In contrast, forested portions exhibit a high species diversity as well as many breeding species, reflecting avian response to the wide diversity of habitats afforded by the compressed elevation gradients and the wide variety of vegetation form caused by logging, fire and grazing.

Occurrence

A list, "Birds of the AWR River Basin", is included in Appendix D. Included are all species of birds for which there are published or reliable unpublished sight records. The list does not include those

bird species which occur as casuals (sightings very infrequent; i.e., every 10 years or less), or at such low numbers as to be characterized as rare. Species which nest in the area are indicated.

To place this list in perspective, in New Mexico there have been 413 species of birds whose occurrence has been substantiated, of which 245 species definitely breed and 25 others probably breed (Hubbard, 1970). While acknowledged to be incomplete, data from the AWR Basin indicate that 268 species have been verified, of which 140 species are known to breed.

Endangered Bird Species

Included in the verified bird list are the American Peregrine falcon and bald eagle, two seasonal migrants which are designated as endangered species by the Fish and Wildlife Service. In addition, the State of New Mexico has designated the white-tailed ptarmigan, a bird which breeds in the high mountains along the northwestern border of the basin, as an endangered species.

Several bird species known to exist within the basin are included in the New Mexico Wildlife Conservation Act, Regulation 563, January 24, 1975. It is believed these species are suffering declines in numbers and/or range to the point where their survival could become severely jeopardized. The red-headed woodpecker is breeding in the basin, while the osprey, bluejay, savannah sparrow, McCown larkspur and brown-capped rosy finch are rare or uncommon seasonally.

Management

Within the AWR Basin there are several units of land and water being managed primarily as bird habitat. The largest is the 3,100 acre Maxwell National Wildlife Refuge. The State Game and Fish Department manages the 735 acre Wagon Mound Wildlife Area and the smaller, private La Cueva area for waterfowl.

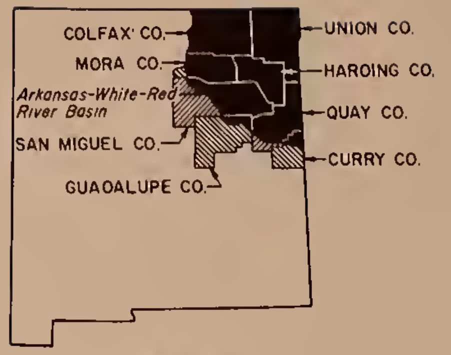
Concentrations of geese and ducks, during winter migrations, move across the grasslands, stopping where open waters and suitable food are available. As winter progresses, and lakes freeze over or food supplies dwindle, birds move further south to other refuges in New Mexico and Texas. Most of the waterfowl have moved north by the early spring; consequently, there are few waterfowl produced in the Basin.

Other than protection of existing habitats, there has been little or no effort directed towards the improvement of bird habitats for other than waterfowl. Habitat improvements which were specifically designed to benefit scaled quail have been applied on National Grasslands. The response of quail populations was negligible and the management efforts have been discontinued.

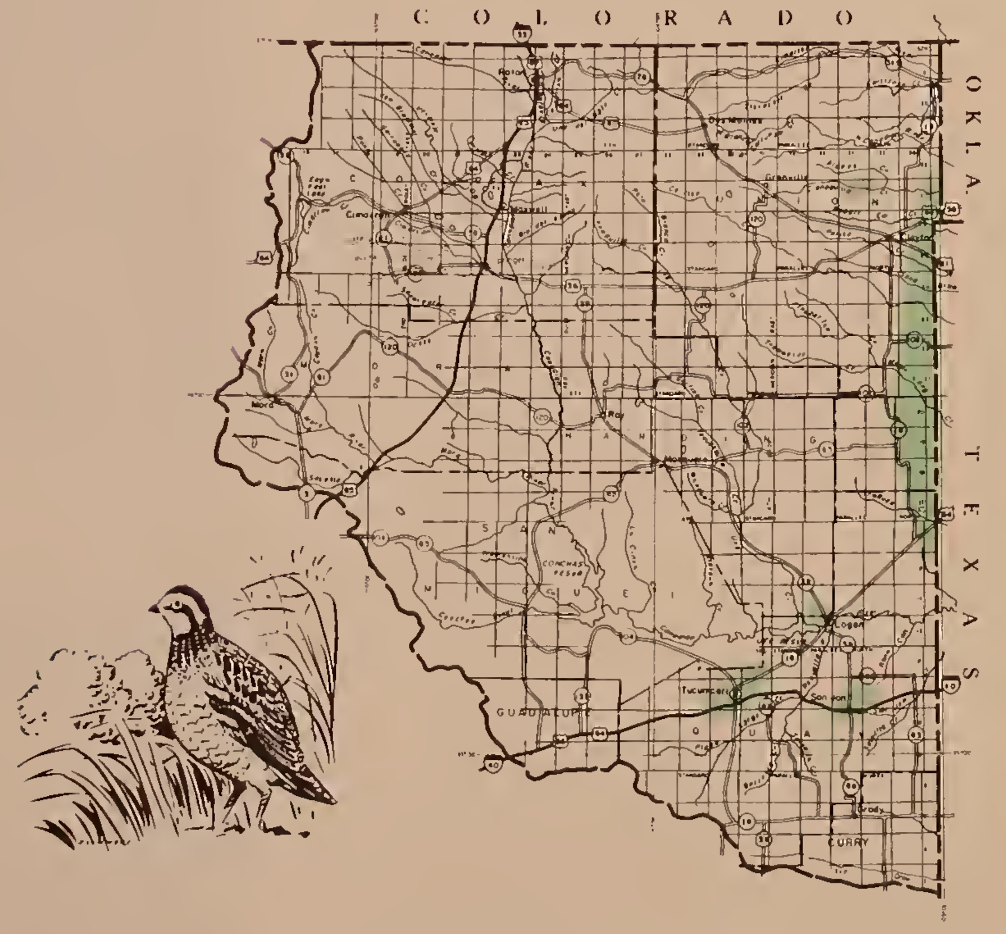
BLUE GROUSE

TURKEY

SCALED QUAIL

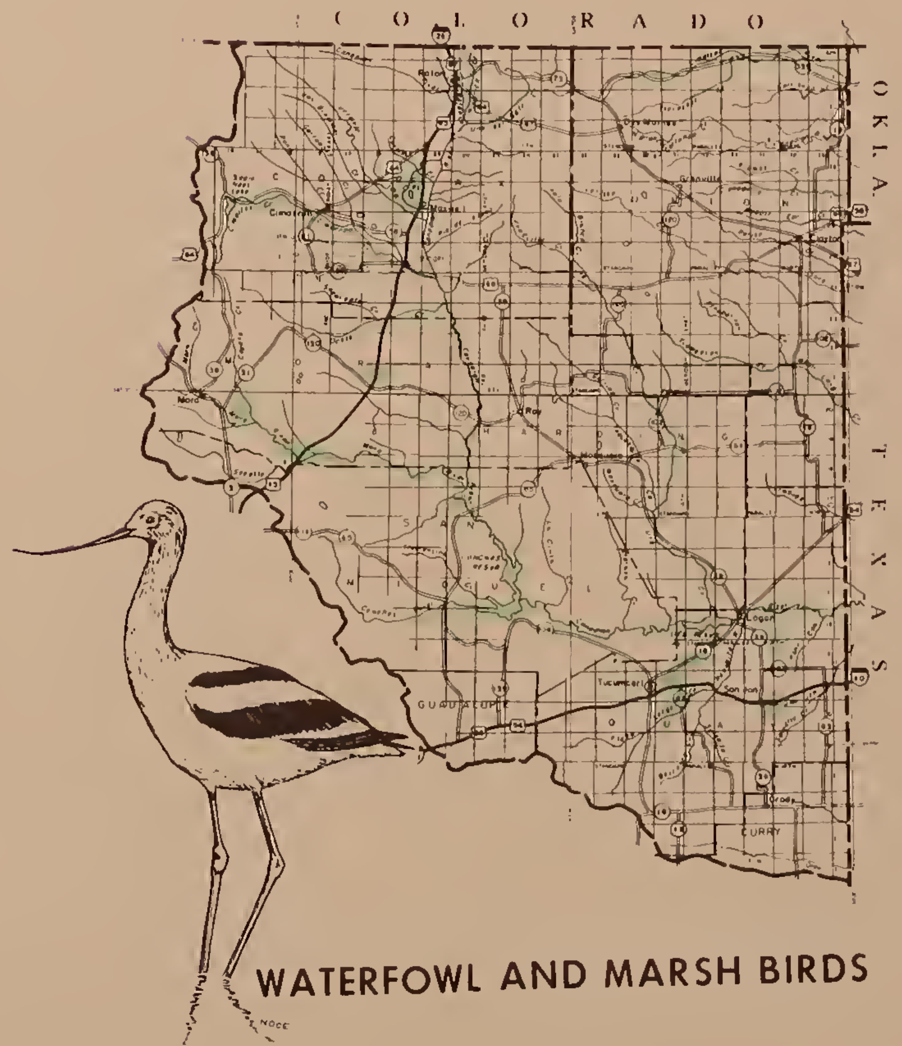


LOCATION MAP



BOBWHITE QUAIL

RINGNECK PHEASANT



WATERFOWL AND MARSH BIRDS

DISTRIBUTION OF GAME BIRDS

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

MAY 1976

20 0 20 40 MILES
SCALE IN MILES

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:1,000,000 Nat. Atlas.
Thematic detail compiled by state staff.

US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-N-22828-16

The value of rangelands as habitats for game and non-game birds depends upon a complex of factors including landscape, nesting sites, singing areas, lookouts, drinking sites, other animals, and food. The quality of several of these factors is directly dependent upon the type and degree of range management which is practiced.

Generalizing, management which tends to produce a plant community of few species, or eliminates foliage-height diversity, or allows the removal of excessive amounts of forage will degrade available bird habitats. Conversely, management which improves these factors, and in addition provides new sources of water, protects rangeland from wildfire and limits the application of insecticides and rodenticides, will produce improvement to bird habitats.

The outstanding importance of riparian woodlands as super-productive bird habitats dictates that these ecosystems receive a high level of protection.

Coniferous forest habitats make up the remainder of the major bird habitats in the Basin. Again, the great diversity and spacings of vegetative form, produced by man through logging, clearing, mining, and roadbuilding, or by wildfire or defoliating insects, have provided many productive bird habitats. The spraying of insecticides can directly affect birds as well as indirectly by changing the available food sources. The role of birds in the forest ecosystem, particularly as predators of insects, and as consumers of tree seeds, has only recently begun to receive systematic study.

Forest management practices which tend to reduce or degrade bird habitats include: planting trees in openings; eliminating old-growth stands; cutting snags; perpetuating even-aged or mono-species stands; and, excessive control of non-damaging wildfire.

It appears that the type of coniferous forest management which is designed to meet multiple objectives--wood products, watershed, forage, wildlife habitat and outdoor recreation, will coincidentally provide for more and better bird habitats.

AMPHIBIANS AND REPTILES

Both land and water habitats provide suitable environments for a variety of amphibians and reptiles. The scarcity of permanent aquatic areas is reflected in the limited numbers of water-dependent species.

Occurrence

Although the systematic collection of herptiles has never been undertaken within the basin, the Museum of Southwestern Biology at UNM has compiled a record of verified occurrences. Included are the ubiquitous tiger salamander, three frogs, five toads, twenty-four snakes, fifteen lizards, the box turtle and six aquatic turtles. Refer to Appendix D, "Occurrence of Reptiles and Amphibians in the AWR."

Endangered Species

Under authorities of the Wildlife Conservation Act of 1974, the New Mexico Department of Game and Fish named 19 reptiles and 5 amphibians as endangered species occurring in New Mexico. Included are two turtles and two snakes which have been reported to occur within this basin. These are: the smooth softshell turtle from the Canadian River, the spiny softshell turtle from both the Canadian and Dry Cimarron Rivers, the rough green snake from near the Village of Cimarron, and the blotched water snake from the Dry Cimarron River.

Management

The collecting of all wild animals is controlled by existing authority of the New Mexico Game and Fish Department. As more refined information is obtained about the endangered species of this area, it is likely that specific management programs will be initiated.

An expansion in the ranges, as well as the numbers, of water-dependent species can be expected to occur as additional water developments are constructed throughout the basin.

There are no lands or waters being managed primarily for reptiles or amphibians.

BIRDS

B-1 Mississippi kite
B-2 White-tailed ptarmigan
B-3 Red-headed woodpecker
B-4 McCown's longspur winters on the high plains

SNAKES

S-1 Rough green snake
S-2 Blotched water snake

TURTLES

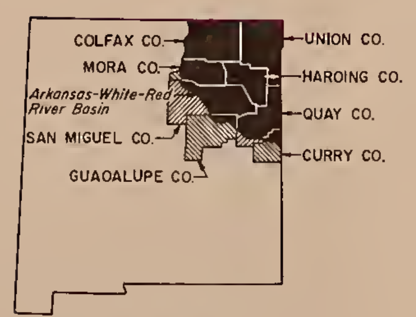
T-1 Smooth softshell
T-2 Spiny softshell

FISH

F-1 Redbelly dace
F-2 Suckermouth minnow
F-3 Brook stickleback

MAMMALS

M-1 Pine martin



LOCATION MAP

ENDANGERED OR THREATENED WILDLIFE 1/

Approximate Occupied Ranges

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

1/ Handbook of Species Endangered in New Mexico. New Mexico Game and Fish Department, 1978

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR 1979

M7-EN-22828-27

LIST OF REFERENCES

BARNES, J. R., et. al., 1949, Geology and Groundwater in the Irrigated Region of the Southern High Plains in Texas, Progress Report No. 7, Texas Board of Water Engineers, prepared in cooperation with the U.S. Department of Interior Geological Survey.

BUCHANAN, D. E. and ROSS, W. J., 1958, Soil Survey of Curry County, New Mexico, Soil Conservation Service, USDA in cooperation with New Mexico Agricultural Experiment Station.

BUCHANAN, W. A., DAVIS, W. H., HUGHES, J. A. and JOHNSON, WARREN, 1960, Soil Survey Southwest Quay Area, New Mexico, Series 1956, No. 14, USDA SCS, in cooperation with New Mexico Agricultural Experiment Station.

Characteristics of the Water Supply in New Mexico. Technical Report 31, 1965, Hale, Reiland, and Beverage.

Climatological Summary New Mexico Precipitation 1849-1954, 1956, Technical Report No. 6, New Mexico State Engineer, USWB.

Climatological Summary New Mexico Temperature 1850-1954 Frost 1850-1954 Evaporation 1912-1954, 1956, New Mexico State Engineer, USWB.

Committee on Water Quality Criteria et al, 1972, Water Quality Criteria 1972. Environmental Protection Agency.

Consumptive Irrigation Requirements of Selected Irrigated Areas in New Mexico. August 1968, NMSU Agricultural Experiment Station, Bulletin 531, Agricultural Experiment Station in cooperation with Water Resources Institute NMSU & New Mexico State Engineer.

Consumptive Use and Water Requirements in New Mexico, Technical Report 32, 1965, Blaney & Hanson.

COOPER, JAMES, B., and DAVIS, LEON V., 1967, General Occurrence and Quality of Groundwater in Union County, New Mexico, Groundwater Report 8, New Mexico Bureau of Mines and Mineral Resources.

Determining Consumptive Use and Water Requirements, Technical Bulletin No. 1275, ARS-USDA and Utah State Engineer.

DINWIDDIE, G. A., 1964, Municipal Water Supply and Uses, Northeastern New Mexico Technical Report 29B, New Mexico State Engineer, prepared in cooperation with United States Geological Survey.

DREGNE, H. E., J. U. Anderson, and H. J. Maker, Oct. 1969, Land Classification for Irrigation, Curry County. New Mexico State Univ. Agricultural Experiment Station, Research Report 162.

Environmental Improvement Agency, 1974, New Mexico Public Water Supplies Chemical Data, Minor Communities, Water Supply Regulation Section, Environmental Improvement Agency, New Mexico Health and Social Services Department.

Environmental Improvement Agency, 1974, Public Water Supplies Chemical Data, Major Communities, Water Supply Section Environmental Improvement Agency, New Mexico Health and Social Services Department.

Environmental Protection Agency, 1974, 1976, Storet Computer Storage of Water Quality Data in the U. S.

Federal Water Pollution Control Administration, 1968, Water Quality Criteria, Report of the National Technical Advisory Committee of the Secretary of the Interior, U. S. Department of Interior.

FENNEMAN, NEVIN M., 1931, Physiography of the Western United States, McGraw-Hill Book Company, Inc.

GRIGGS, R. L., 1948, Geology and Groundwater Resources of the Eastern Part of Colfax County, New Mexico, Groundwater Report 1, New Mexico Bureau of Mines and Mineral Resources.

GRIGGS, R. L., and HENDRICKSON, G. E., 1951, Geology and Groundwater Resources of San Miguel County, New Mexico, Groundwater Report 2, New Mexico Bureau of Mines and Mineral Resources.

HEM, JOHN D., 1970, Study and Interpretation of the Chemical Characteristics of Natural Water, 2nd ed. Geological Survey Water-Supply Paper 1473, U.S. Department of Interior, Geological Survey.

KOTTLOWSKI, Frank E., 1964, The Economic Geology of Coal in New Mexico, New Mexico Bureau of Mines and Mineral Resources, Circular 71.

MAKER, H. J., and others, April 1970, Soil Association and Land Classification for Irrigation, Harding County, Agricultural Experiment Station Research Report 165.

____________________, August 1971, Soil Associations and Land Classification for Irrigation, Quay County, New Mexico State University Agricultural Experiment Station Research Report 202.

____________________, Sept. 1971, Soil Associations and Land Classification for Irrigation, Mora County, New Mexico State University Agricultural Experiment Station Research Report 205.

____________________, April, 1972, Soil Associations and Land Classification for Irrigation, San Miguel County, New Mexico State University Agricultural Experiment Station Research Report 221.

__________________, December, 1972, Soil Associations and Land Classification for Irrigation, Colfax County, New Mexico State University Agricultural Experiment Station Research Report 239.

__________________, February, 1973, Soil Associations and Land Classification for Irrigation, Guadalupe County, New Mexico State University Agricultural Experiment Station Research Report 246.

__________________, May, 1973, Soil Associations and Land Classification for Irrigation, Union County, New Mexico State University Agricultural Experiment Station Research Report 250.

__________________, 1974, Soils of New Mexico, Research Report 285, Agricultural Experiment Station, New Mexico State University.

MERCER, JERRY W., and LAPPALA, ERIC G., 1970, A Geophysical Study of AlluvialValleys in Western Mora County, New Mexico, U.S. Department of Interior, Geological Survey, prepared in cooperation with the New Mexico State Engineer, The Four Corners Regional Commission, and the Soil Conservation Service.

__________________, 1971, Ground water Resources of the Mora River Drainage Basin Within Mora County, New Mexico, New Mexico Tech Report 37, U.S. Department of Interior, Geological Survey, prepared in cooperation with the Office of the State Engineer, the Soil Conservation Service, and The Four Corners Regional Commission.

National Atlas of the United States of America, 1970. U. S. Department of Interior, Geological Survey, page 63, Classes of Land Surface Form. Adapted from Edwin H. Hammond, 1964.

New Mexico Conservation Needs Committee, January 1970, Conservation Needs Inventory Statistical Report, (1966-1967 inventory data).

New Mexico Department of Game and Fish, 1975, Statewide Fisheries Investigations, F-22-R-16, Job 1-3, 5/20/75.

New Mexico State Planning Office, 1969, The Climate of New Mexico, Santa Fe, New Mexico.

__________________, 1973, The Climate of New Mexico, Santa Fe, New Mexico.

__________________, 1967 Water Resources of New Mexico, compiled by the New Mexico State Engineer Office in cooperation with New Mexico Interstate Stream Commission and the U. S. Geological Survey.

New Mexico State Water Assessment, November 1976, Bureau of Reclamation in cooperation with the State of New Mexico.

New Mexico Water Quality Standards, August 1973, New Mexico Water Quality Control Commission.

PEASE, DOUGLAS S. and others, 1973, Soil Survey of Harding County New Mexico, USDA, Soil Conservation Service in cooperation with New Mexico Agricultural Experiment Station.

ROSS, W., JAMES, and PEASE, DOUGLAS, 1974, Soil Survey of Tucumcari Area, New Mexico, Northern Quay County, USDA, Soil Conservation Service in cooperation with New Mexico Agricultural Experiment Station.

Soil Conservation Service, 1970, Irrigation Water Requirements Technical Release No. 21, April 1967, revised September 1970, USDA-SCS.

SORENSEN, Earl F., 1977, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated and Dry Cropland Acreage in 1975, Technical Report 41, New Mexico State Engineer, Santa Fe, New Mexico.

U.S. Geological Survey, 1954, Surface Water Supply of the United States, 1951, Part 7. Lower Mississippi River Basin, Geological Survey Water-Supply Paper 1211.

____________________, 1955, Compilation of Records of Surface Water of the United States through September 1950, Part 7 Lower Mississippi River Basin, Geological Survey Water-Supply Paper 1311.

____________________, 1955, Surface Water Supply of the United States, 1952, Part 7. Lower Mississippi River Basin, Geological Survey Water-Supply Paper 1241.

____________________, Surface Water Supply of the United States, 1955, Geological Survey Water-Supply Paper 1381.

____________________, 1964, Compilation of Records of Surface Waters of the United States, October 1950 to September 1960, Part 7. Lower Mississippi River Basin, Geological Survey Water-Supply Paper 1731.

____________________, 1969, Surface Water Supply of the United States, 1961-1965, Part 7. Lower Mississippi River Basin Volume 2. Arkansas River Basin, Geological Survey Water-Supply Paper 1921.

____________________, 1974, Surface Water Supply of the United States, 1966-70, Part 7. Lower Mississippi River Basin, Volume 2 Arkansas River Basin, Geological Survey Water-Supply Paper 2121.

United States Geological Survey, Water Resources Data for New Mexico, Part 1, Surface Water Records, prepared in cooperation with the State of New Mexico for years of 1970-1974.

CHAPTER 4

ECONOMIC DEVELOPMENT

This chapter briefly describes the historical development of the basin. The socio-economics of the basin are viewed in the areas of education, population, economic activities, employment and unemployment, income, welfare, urban centers and their influence, and transportation. Agriculture, outdoor recreation, forest resources, range resources, water requirements, and the related economic activities of each are given separate consideration.

Projections are presented of the future level of agricultural production, resource use, and income and employment in industries affected by changes in agriculture, assuming that the USDA ongoing program will not change.

CHAPTER 4. ECONOMIC DEVELOPMENT

FIGURES

HISTORICAL DEVELOPMENT

The Arkansas-White-Red River Basin was originally inhabited by nomadic Indians. However, during the period of Spanish exploration the Comanches left their ancestral lands in what is now Wyoming and invaded the Apaches, who occupied the basin at the time. The Comanches won significant battles and soon gained undisputed control of the land east of the Pecos River.

Coronado and Onate traversed the basin in the 1500's while searching for Quivira, the mythical city of gold. Quivira was never found because it was invented by the Indians to divert the Spaniards to the north. Onate was given the task of conquest of the area and he eventually became Governor of the Spanish province containing what is now New Mexico.

The Spanish and Comanches established relations which changed from friendly to hostile depending on the advantage to be gained by either party. The Comanches obtained horses and weapons from the Spanish while the Spanish obtained furs and military aid against the Apaches from the Comanches.

Influence of the United States increased during the era of the beaver trapping "mountain men" and after the opening of the Santa Fe Trail in 1821.

Trade and settlement increased with the opening of the trail, which traversed the basin. Conquest of New Mexico during the Mexican-American War was made easier by the presence of many American settlers and traders. General Kearny and his "Army of the West" entered the basin through Raton Pass, continued to Las Vegas, and went on to capture Santa Fe in August 1846, after a bloodless campaign.

During the Civil War, the Battle of Glorieta Pass secured New Mexico for the Union government. Conflict between settlers and the Comanches continued after the Civil War, until the defeat of the Comanches in 1874.

Railroad linkage with the rest of the United States occurred in 1879. The railroad crossed the basin generally along the route of the Santa Fe Trail and the railroad was an important factor in the settlement and development of the Territory of New Mexico. New Mexico was granted statehood in 1912. 1/

Prior to World War II, New Mexico's economy was based largely upon agriculture and mining. The major stimulus to the state's growth since

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1/ Sources of information for the preceding section were: Beck, Warren A., New Mexico, A History of Four Centuries, 1962 Mann and Harvey, New Mexico, Land of Enchantment, 1955.

World War II has been the expansion of federal defense and nuclear related activities. The state's population grew from 681,187 in 1950 to over 1 million in 1970. Employment grew from 218,000 to nearly 340,000 in the same period.

SOCIO-ECONOMIC

EDUCATION

Educational levels in the basin are lower than for New Mexico as a whole. More than 56 percent of the basin's residents 25 years of age or older had less than a high school education in 1970. About 23 percent had less than an eighth grade education. Median educational characteristics are shown in Table 4-1.

TABLE 4-1. MEDIAN SCHOOL YEARS COMPLETED BY PERSONS 25 YEARS OF AGE OR OLDER 1970; ARKANSAS-WHITE-RED RIVER BASIN.

	Median school years completed
Colfax	11.5
Harding	9.8
Mora	8.2
Quay	11.3
Union	12.0
AWR Basin	11.0
New Mexico	12.2
U. S.	12.1

Source: U.S. Census of Population: 1970

POPULATION AND POPULATION CHARACTERISTICS

Unlike New Mexico as a whole, the basin declined in population and employment between 1950 and 1970. 1/ Growth in nonagricultural sectors of the economy has not been sufficient to offset losses in agricultural employment opportunities. As employment opportunities declined, people left to seek employment elsewhere.

1/ Because more than 98 percent of the basin's population resides in Colfax, Harding, Mora, Quay, and Union Counties, socio-economic data for those counties are used to represent the basin in this chapter. Portions of Curry, Guadalupe, and San Miguel Counties are within the basin's hydrologic boundaries. Use of whole county data to represent the socio-economic situation results in less than a two percent error in measurement of the basin's total population.

TABLE 4-2. HISTORICAL POPULATION BY COUNTY, BASIN, AND STATE

	1930	1940	1950	1960	1970	1975
Colfax :	19,200	18,700	16,800	13,800	12,200	13,000
Harding :	4,400	4,400	3,000	1,900	1,300	1,200
Mora :	10,300	11,000	8,700	6,000	4,700	4,800
Quay :	10,800	12,100	14,000	12,300	10,900	11,300
Union :	11,000	9,100	7,400	6,100	4,900	4,900
AWR Basin * :	55,700	55,300	49,900	40,100	34,000	35,200
New Mexico :	423,300	531,800	681,200	951,000	1,016,000	1,147,000

Sources: (1) U.S. Census of Population, New Mexico
(2) Bureau of Business and Economic Research
(3) U. S. Department of Commerce. Current Population Reports, July, 1977.

* Does not include population of Curry, Guadalupe, and San Miguel Counties.

RACIAL AND ETHNIC COMPOSITION

The racial composition of the basin's population is more homogeneous than that of New Mexico as a whole. Whites comprised 99 percent of the population in 1970 compared to 90 percent of the state. Persons of Spanish language or surname accounted for 50 percent of the population, compared to 40 percent for the state.

TABLE 4-3. PERSONS OF SPANISH LANGUAGE OR SURNAME - 1970
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Number	Percent of total population
Colfax	6,464	53.1
Harding	664	49.3
Mora	4,419	94.6
Quay	3,924	36.0
Union	1,395	28.2
AWR Basin	16,866	49.6
New Mexico	407,828	40.1

Source: U. S. Census of Population: 1970

EMPLOYMENT

Historical employment is shown in Table 4-4. Employment changes by industry groupings are shown in Table 4-5. Of the five industries that declined in employment between 1950 and 1970, agriculture, transportation, communications, and utilities accounted for 86 percent of the lost jobs. The employment decline in agriculture was caused by technological changes that allowed fewer persons to produce more goods and services. The decline in the "transportation, communications, and utilities" group's employment was caused by similar changes in technology. A major factor was that the railroads switched from steam to diesel power locomotives. The decline in coal mining employment resulted from the advent of diesel locomotives. However, in recent years, employment has increased in the Colfax County coal mines with the increased national demand for low-sulphur coal.

TABLE 4-4. HISTORICAL EMPLOYMENT BY COUNTY, BASIN, AND STATE

	1940	1950	1960	1970	1975
Colfax	5,005	5,148	4,314	3,991	5,013
Harding	934	886	544	447	542
Mora	1,959	1,874	888	832	887
Quay	3,434	4,571	3,989	3,982	4,520
Union	2,402	2,452	1,997	1,758	1,976
AWR Basin 1/	13,734	14,931	11,732	11,010	12,938
New Mexico	140,300	218,200	309,800	338,600	399,717

Sources: Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Office of Business Economics, U.S. Department of Commerce.
New Mexico Labor Market Review, 1977
U.S. Census of Population; 1970

1/ Does not include employment in Curry, Guadalupe, and San Miguel Counties.

Four Industry Groups: "Services," "Public Administration," "Manufacturing," and "Finance, Insurance, and Real Estate" grew in employment between 1950 and 1970. Services and public administration (federal and nonfederal) accounted for 85 percent of the increased job opportunities. Increases in these sectors were due to growth in tourism in the basin, national trends toward a service oriented economy, and growth in government expenditures.

TABLE 4-5. CHANGE IN EMPLOYMENT BY INDUSTRY, 1950-1970, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO (IN NUMBERS OF PERSONS)

Employment Increased	Employment Change 1950-1970	Employment Declined	Employment Change 1950-1970
Services	+ 468	Agriculture	- 2,804
Public administration	+ 188	Trans., comm., utilities	- 769
		Mining	- 390
Manufacturing	+ 86		
		Wholesale, retail trade	- 158
Finance, insurance, real estate	+ 30		
		Contract construction	- 38
Growth industry total	+ 772	Declining industry total	- 4,159

Sources: Growth Patterns in Employment by County, 1940-1950and 1950-1960, Bureau of Economic Analysis, U.S. Department of Commerce
U.S. Census of Population: 1970

TABLE 4-6. EMPLOYMENT BY INDUSTRY, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Industry	1940	1950	1960	1970
Agriculture	5,203	4,723	2,401	1,919
Mining	1,075	655	168	265
Contract construction	783	1,010	872	972
Manufacturing	348	572	629	658
Trans., comm., utilities	1,164	1,573	1,216	804
Wholesale and retail trade	1,895	2,464	2,508	2,306
Finance, insurance, real estate	151	246	280	276
Services	2,479	2,551	2,622	3,019
Public admin.	500	603	721	791
Industry not reported	136	534	315	1/
Total, all industries	13,734	14,931	11,732	11,010

Sources: Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Bureau of Economic Analysis, U.S. Department of Commerce.
U.S. Census of Poulation: 1970

Employment by industry for the basin and the state is shown in Tables 4-6 and 4-7. The agricultural and tourist orientation of the basin's economy is indicated by the importance of agriculture, trade, and services. These three industries accounted for 66 percent of basin employment in 1970. While tourism is also important for the state as a whole, agriculture is less significant in terms of total employment in the state's economy. Agriculture accounted for less than 5 percent of total employment in the state in 1970, compared to more than 17 percent in the basin.

TABLE 4-7. EMPLOYMENT BY INDUSTRY IN NEW MEXICO

Industry	1940	1950	1960	1970
Agriculture	44,894	37,942	20,414	15,352
Mining	8,831	10,522	19,236	17,943
Contract construction	8,364	23,380	26,780	23,774
Manufacturing	8,973	12,146	21,668	21,832
Trans., comm., utilities	9,300	17,247	22,092	21,819
Wholesale and retail trade	21,633	39,145	55,361	67,876
Finance, insurance, real estate	1,980	4,550	9,560	13,398
Services	27,363	42,403	78,616	112,118
Public admin. and armed forces	6,265	25,209	46,703	44,480
Industry not reported	2,666	5,624	9,382	1/
Total, all industries	140,269	218,168	309,812	338,592

Sources: Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Bureau of Economic Analysis, U. S. Department of Commerce. U. S. Census of Population: 1970

1/ Not Available.

UNEMPLOYMENT

The unemployment rates for the basin counties are shown in Table 4-8. The 1976 average number of unemployed persons in each county is also shown. The larger protions of Curry, Guadalupe, and San Miguel Counties fall outside of the basin boundaries.

TABLE 4-8. UNEMPLOYMENT, 1975 ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Annual Unemployment Rate (Percent)	Numbers Unemployed
Colfax	9.8	546
Curry	7.2	1,025
Guadalupe	13.0	199
Harding	4.4	25
Mora	34.8	473
Quay	5.9	282
San Miguel	15.9	1,172
Union	4.9	102
Basin Whole-County Total	10.2	3,824
New Mexico	10.0	44,578

Source: New Mexico Employment Security Commission, New Mexico Labor Market Review, 1977

INCOME

Average income levels in the basin are below state and national averages. With the exception of Mora County, income levels of the basin counties are roughly comparable. Per capita income in Mora County is about one-half that of the rest of the basin. Per capita and family income levels are shown in Tables 4-9 and 4-10.

In the basin, about 26 percent of families and 31 percent of all persons had incomes below the poverty level in 1969. 1/ About nine percent of families had incomes in excess of $15,000. In New Mexico, as a whole, about 19 percent of families had incomes below the poverty level, while 15 percent had incomes exceeding $15,000.

1/ U. S. Census of Population, 1970; General Economic and Social Characteristics, Vol. PC(1)-C. The official criterion of poverty for a farm resident in 1969 was an annual income ranging from $1,569 for one person to $5,180 for a family of seven persons or more. (For four persons it was $3,197.)

TABLE 4-9. NUMBER AND PERCENT OF FAMILIES BY INCOME CLASS, 1969
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Family income class		
	Less than $3,000	$ 3,000 to $10,000	Over $10,000
	Number of families		
Colfax	507	1,825	744
Harding	82	184	84
Mora	516	461	78
Quay	503	1,534	757
Union	328	786	255
AWR Basin	1,936	4,790	1,918
	Percent of families		
Colfax	16.5	59.3	24.2
Harding	23.4	52.6	24.0
Mora	48.9	43.7	7.4
Quay	18.0	54.9	27.1
Union	24.0	57.4	18.6
AWR Basin	22.4	55.4	22.2

Source: U.S. Census of Population: 1970

TABLE 4-10. FAMILY AND PER CAPITA INCOME, 1969
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Percent of families with income less than poverty level	Percent of families with income of $15,000 or more	Median family income	Per Capita income
Colfax	20.1	9.6	6,596	2,196
Harding	28.3	10.0	6,500	2,257
Mora	57.3	2.1	3,100	1,048
Quay	19.3	9.1	6,794	2,348
Union	26.2	9.7	5,295	2,354
AWR Basin	25.7	8.7	6,126	2,111
New Mexico	18.5	14.8	7,849	2,449

Source: U. S. Census of Population: 1970

URBAN DEVELOPMENT

The basin has only four towns with populations exceeding 1,000 persons. Because there are no large urban centers, the basin's regional economic activity is shared between Amarillo, Albuquerque, and Pueblo, Colorado.

Populations of basin cities are shown in Table 4-11. Although the towns have declined in population, the rate of decline has been less than for the basin as a whole. The town population declined by 16 percent between 1950 and 1970, compared to a decline of 31 percent for the basin as a whole. The population of towns with more than 1,000 inhabitants declined by less than 14 percent. About 55 percent of the population lived in these larger towns in 1970, compared to 44 percent in 1950.

TABLE 4-11. HISTORICAL POPULATION OF TOWNS WITH MORE THAN 1,000 INHABITANTS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Population		
Town	1950	1960	1970
Raton	8,241	8,146	6,962
Springer	1,558	1,564	1,574
Tucumcari	8,419	8,143	7,189
Clayton	3,515	3,314	2,913

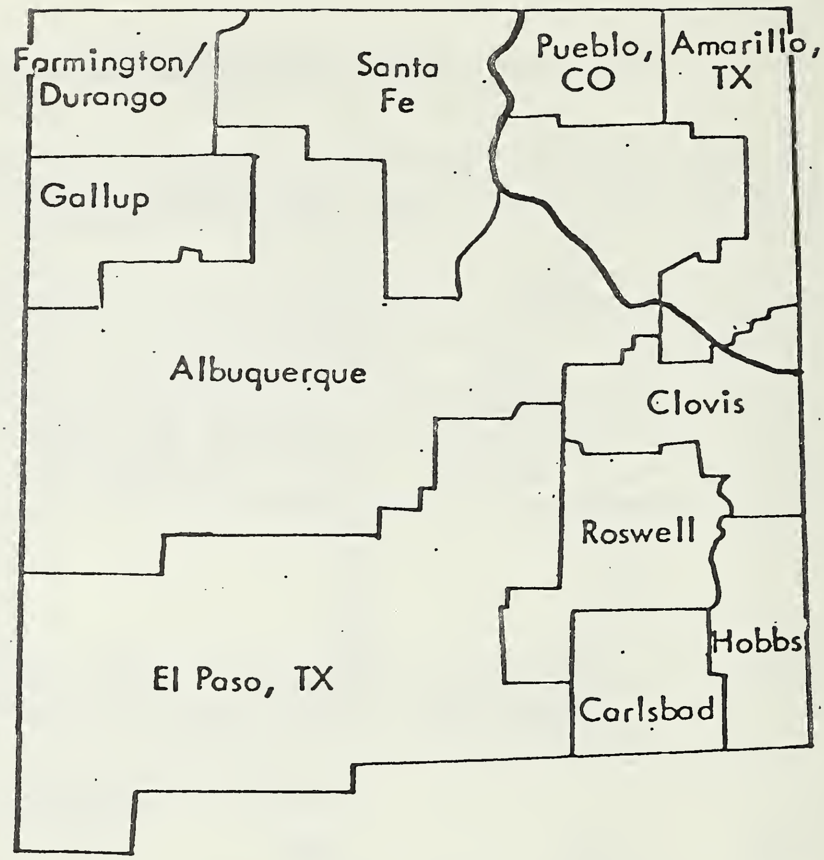
Source: New Mexico Statistical Abstract, 1972

URBAN CENTERS AND THEIR INFLUENCE

Amarillo, Texas is the major trading center for the eastern portion of the basin. Pueblo, Colorado is a local trading center serving the northern basin area. Albuquerque serves the balance of the basin. Other trading centers are shown in Figure 4-1.

FIGURE 4-1. NEW MEXICO BASIC TRADING CENTERS.

SOURCE: RAND McNALLEY MARKETING ATLAS, 100TH EDITION



AGRICULTURE AND RELATED ECONOMIC ACTIVITY

Sales of agricultural products from the basin's farms and ranches exceeded $58 million in 1969. Sales of livestock and livestock products accounted for 90 percent of the value of agricultural products sold, while cattle accounted for about 99 percent of the value of the livestock marketed.

Farms and ranches in the basin are becoming larger, more specialized, and fewer in number. Between 1954 and 1969, the average size increased from 3,000 acres to 4,500 acres; the average value of land and buildings per unit increased from $45,000 to $180,000; and the average value of agricultural products sold increased from $5,900 to $31,000 per farm or ranch. Production of cattle and calves, hay, pasture, and grain has increased, while other agricultural commodities have declined in importance. Over 78 percent of the farms were classified as livestock farms or ranches in 1969.

Between 1954 and 1969, the number of farms and ranches in the basin declined from nearly 3,000 to less than 1,900--a decline of more than 36 percent. All of the decline was accounted for by farms or ranches with sales of less than $40,000. Farms and ranches with sales of $40,000 or more increased by 76 percent between 1954 and 1969. These larger units accounted for less than 13 percent of the farms and ranches, but sold about 74 percent of the basin's agricultural productions. Despite the consolidation of farm and ranch units, 60 percent still had sales of less than $10,000 and 27 percent had sales of less than $2,500 in 1969.

TABLE 4-12. FARM CHARACTERISTICS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	1954	1959	1964	1969	1974
Total value of farm products sold, millions of dollars	17.7	30.6	20.9	58.8	88.5
Total value of livestock and livestock products sold, millions of dollars	15.1	26.4	22.1	53.2	79.5
Average value of farm products sold per farm, dollars	5,900	12,600	11,500	31,000	51,200
Number of farms	2,998	2,427	2,163	1,895	1,730
Average farm size, acres	2,989	3,360	4,084	4,501	5,075
Average value of land and buildings per farm, dollars	45,000	64,000	124,000	180,000	329,000
Average value of land and buildings per acre, dollars	17	22	29	40	65

Source: U. S. Census of Agriculture

TABLE 4-13. LIVESTOCK INVENTORY, ANIMALS ON FARMS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Type of livestock	1954	1959	1964	1969	1974
Cattle and calves	295,000	275,800	260,300	355,000	397,000
Hogs and pigs	6,500	8,400	6,000	7,000	10,100
Sheep and lambs	59,100	40,300	23,100	9,500	15,200
Chickens	131,000	79,300	43,200	18,500	19,300
Horses and mules	7,900	6,700	N/A	5,100	N/A

Source: U.S. Census of Agriculture and New Mexico Agricultural Statistics

Descriptive statistics in Tables 4-1 through 4-14 are based on a whole county approximation of the basin. Time series data for the land area coincident with the basin's hydrologic boundaries are not available.

Hay, wheat, corn, and sorghum are the major crops grown. Much of the hay and silage is fed to livestock on farms where it is produced. Production of corn has increased rapidly since 1968. Production of broomcorn has declined as farmers have switched to crops with lower labor requirements. (See Table 4-15)

Crop production and acreage harvested fluctuate widely with weather conditions. In drought years, yields of nonirrigated crops harvested may decline by more than 50 percent. Some production may be realized from livestock grazing when crops are not harvested due to dry weather. Yields of irrigated crops may also decline in dry years when irrigation water supplies are inadequate to provide for normal crop requirements. Rangeland conditions are similarly affected. When growth of range grasses is hampered by inadequate rainfall, cattle numbers are often not reduced in sufficient time to avoid overgrazing and further deterioration of range conditions.

TABLE 4-14. NUMBER OF FARMS BY SALES CLASS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Sales class	1954	1959	1964	1969
$40,000 and over	135	170	123	238
$20,000 to $39,999	294	166	148	223
$10,000 to $19,999	415	332	263	299
$5,000 to $9,999	470	386	341	321
$2,500 to $4,999	451	449	340	308
Less than $2,500	1233	924	948	506

Source: U.S. Census of Agriculture.

TABLE 4-15. EXTENT AND USE OF CROPLAND AND PASTURE
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	1959	1964	1969	1974
	Acres			
Irrigated cropland				
Cotton	2,670	2,740	2,000	1,640
Corn, grain	1,950	250	2,380	9,050
Corn, silage 1/	1,100	970	4,670	1,780
Sorghum, grain	15,460	11,820	19,350	12,610
Sorghum, silage	N/A	800	140	240
Wheat	5,200	3,650	6,630	13,620
Alfalfa hay	14,460	13,850	21,300	17,860
Other hay	29,770	27,500	24,700	18,700
Other harvested crops 2/	1,510	4,620	5,010	7,410
TOTAL acres harvested 1/	72,120	66,200	86,180	82,910
Cropland unharvested	10,350 1/	15,080 1/	22,840 1/	62,570
Cropland pasture 1/	N/A	N/A	6,410 1/	9,640 1/
Other cropland 3/	N/A	N/A	16,430 1/	52,930 4/
TOTAL irrigated cropland	82,470 1/	81,280 1/	109,020 1/	145,480
Irrigated pasture 1/	8,700 5/	10,810	21,910	10,300
TOTAL acres developed for irrigation	91,170 1/	92,090 1/	130,930 1/	155,780 6/
Non-irrigated cropland				
Sorghum, grain	25,070	5,400	28,600	18,000
Sorghum, silage 1/	29,090	8,010	19,560	3,750
Wheat	69,000	25,350	38,570	39,800
Other harvested crops 2/	90,820	55,490	74,950	37,520
TOTAL acres harvested	213,980	94,250	161,680	99,070
Cropland unharvested	333,440 1/	486,540 1/	399,950 1/	398,470 4/
Cropland pasture	N/A	N/A	135,680 1/	139,670 1/
Other cropland 3/	N/A	N/A	264,270 1/	289,050 4/
TOTAL dry cropland	547,420 1/	580,790 1/	561,630 1/	527,790 6/

Source: New Mexico Agricultural Statistics (Except as noted).

1/ From U. S. Census of Agriculture.

2/ Acreage of other harvested crops consists of the total of acreage of harvested crops from the U. S. Census of Agriculture minus the acreage of specified crops listed here, reported in New Mexico Agricultural Statistics.

3/ Other cropland includes idle and fallow cropland, crop, failure acreage, and cropland in cover crops, legumes, and soil-improvement.

4/ Includes classes in Note 3, plus the difference between total cropland reported by New Mexico State Engineer Office & U. S. Census of Agriculture.

5/ Estimated by interpolation from 1954 and 1964 census.

6/ Estimated by New Mexico State Engineer Office.

M I N I N G

COAL

Kaiser Steel Company acquired a considerable portion of the Raton Basin coal reserves in New Mexico in 1955. With this, coal mining in the Arkansas-White-Red River Basin began an upward trend. The 1973 production was about 1,000,000 short tons. The York Canyon No. 1 Mine and the West York Strip, both Kaiser mines, employed 262 people. The coal is shipped to Kaiser's steel mill at Fontana, California.

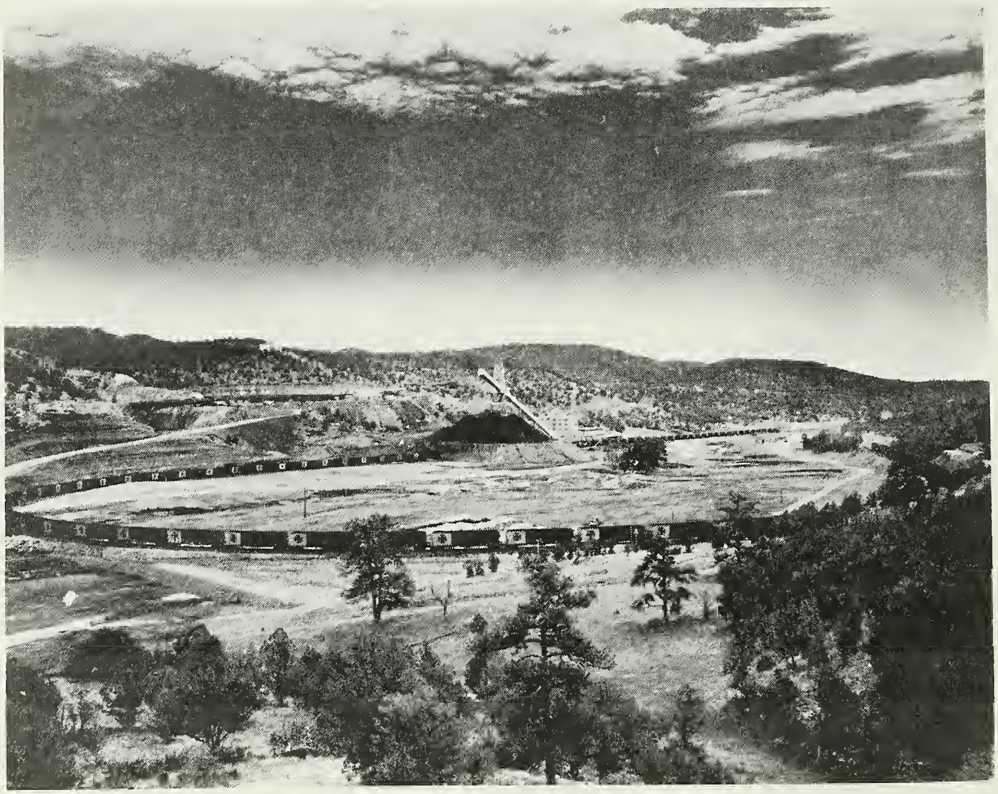


PHOTO 4-1. Coal train loading at Kaiser Steel Corporation's York Canyon Coal Mine, Colfax County for shipment to its California steel mill. Kaiser Steel Corporation photo.

The Raton coal field contains estimated reserves of 4.7 billion tons of bituminous coal. 1/ The coal is in seams 28 inches thick or more and to depths of 3,000 feet. Most coal in the Raton field is of coking quality.

1/ Kottlowski, Frank E., 1964, the Economic Geology of Coal in New Mexico, New Mexico Bureau of Mines and Mineral Resources, Circular 71.

PHOTO 4-2. Coal mining at Kaiser Steel Corporation's York Canyon mine. Kaiser Steel Corporation photo.

CARBON DIOXIDE

Carbon dioxide (CO_2) is found in wells mainly in Harding County, with Union, Mora, and Colfax having wells also.

Carbon dioxide discovery in the basin is a by-product of oil exploration. There are a total of 56 wells encountering CO_2 in the Arkansas-White-Red River Basin. 1/

Five carbon dioxide plants have been built in the Arkansas-White-Red River Basin, four in Harding County and one near Des Moines in Union County. Presently only the SEC plants near Solano and Bueyeros, Harding County, are in operation. One plant south of Bueyeros on Ute Creek uses one well and has a production of about 60 tons per day of liquid CO_2. The main plant at Solano, utilizing CO_2 from the Tequesquite Creek Wells, produces about 180 tons of liquid and block CO_2 daily.

1/ Foster, R. W., and Jansen, James G., 1972, Carbon Dioxide in Northeastern N.M. in N.M. Geological Society Guidebook, Twenty-third field conference, Central New Mexico, 1972.

Anderson, Eugene C., 1959, Carbon Dioxide in New Mexico (1959), New Mexico Bureau of Mines and Mineral Resources, Socorro, N.M.

PHOTO 4-3. Carbon Dioxide Plant - Solano, NM

The main use of CO_2 from the SEC plants is in the meat industry for the quick-freezing of meat. Another major user is the petroleum industry, with carbon dioxide being used in the fracturing of wells to improve the porosity of the rock. A possible new market may be as an aerosol propellant.

Improved packaging and transportation have expanded the market for the Salano plant, with markets as far away as Los Angeles, Billings, Montana, and Houston. Exploration for carbon dioxide gas was conducted in 1974.

OIL AND NATURAL GAS

There has been a natural gas field developed and in production since about 1976 about two miles north of Wagon Mound, Mora County. At present (1979), there are eight wells in production. The gas is being sold to

TABLE 4-16. MINERAL PRODUCTION BY COUNTY, 1969
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

County	Minerals Produced	Value of Production -dollars-
Colfax	Coal, sand and gravel, stone	8,500,000 1/
Harding	Carbon dioxide	69,000
Mora	Sand and gravel, stone	743,000
Quay	Sand and gravel	35,000
Union	Pumice, sand gravel, stone	W 2/

Source: Richard B. Smith, "The Mineral Industry in New Mexico," Minerals Yearbook, 1970, U. S. Bureau of Mines.

1/ Estimated value of production. Actual values not available due to disclosure rules.

2/ Data withheld due to disclosure rules.

the Raton Natural Gas Company for distribution. In addition to the production wells, there are eight shut-in wells, several have been plugged, and several are temporarily abandoned.

Exploration for oil has been conducted for many years in the basin. To date, no development has taken place.

CONSTRUCTION MATERIALS

There are a number of construction materials available in the Arkansas-White-Red River Basin, New Mexico. Sand, gravel, caliche, and volcanic rock are the most readily available and most commonly used. Clay, scoria, crushed rock, lightweight aggregate, and granite have all been quarried and sold in the Arkansas-White-Red River Basin. Scoria is commonly sold outside the river basin area. Sand, gravel, and caliche are seldom transported far from the source because of the relative abundance of the material and the high cost of transportation. Crushed rock is sometimes transported outside the basin.

In 1973, there were eight commercial sand and gravel mining operations in the Arkansas-White-Red River Basin, with the material being used mainly as concrete aggregate. Commercial production of sand and gravel is estimated at about 50,000 cubic yards per year. This includes 15,000 cubic yards annually used by Kaiser Steel to maintain the road to York Canyon coal mine. Kaiser's reserves are approximately 50,000 cubic yards. Other reserves are not known.

The State Highway Department has about 285 sites where they mine sand and gravel. In addition, they have 130 sites where they obtain various volcanic rock. This volcanic rock includes basalt, dacite, cinders (scoria), and rhyolite. They have 186 caliche sites and seven limestone quarries and two sources of sandstone. All of these sites are within the Arkansas-White-Red River Basin and are used for producing road base and aggregate.

Between 1970 and August 1975, the State Highway Department used about 240,000 cubic yards of material for highway maintenance in the Arkansas-White-Red River Basin. This includes sand, gravel, caliche, cinders, and sandstone, and is not expected to increase significantly in quantity.

The parts of Guadalupe, San Miguel, and Curry Counties which are in the basin have small reserves of gravel, and these limited supplies are being depleted.

There are large reserves of expandable shale, a potentially good lightweight aggregate material. Lightweight aggregate is used in concrete block, precast walls, floors, roof slabs, and highway construction. Scoria (cinders) is the only material presently used as lightweight aggregate. In addition to lightweight aggregate, much of the scoria is used for landscaping, railroad ballast, roofing, and building block. Mineral production by county is shown in Table 4-16.

P R O J E C T I O N S

Projections are needed in order to give planners a view of what economic and environmental problems may appear and/or become more serious in future years. They also aid in showing how contemplated public programs and projects would affect people through changing their economic and environmental conditions.

The University of New Mexico's Bureau of Business and Economic Research (BBR) developed population projections for the basin with the aid of the U. S. Department of Commerce, Bureau of Economic Analysis (BEA) and the 1970 U. S. census results. (See Table 4-17.)

TABLE 4-17. POPULATION PROJECTIONS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

YEAR	POPULATION
1980	39,000
2000	46,300
2020	53,900

Source: Estimates are from unpublished 1972 materials from Dr. Lee B. Zink, University of New Mexico, Bureau of Business Research.

The New Mexico State Engineer Office (SEO) developed projections of water withdrawal and consumptive use for the general categories of water use, based on the BEA-BBR population projections. (See Table 4-18.)

The projection of water use by general category is based upon the past popluation growth in the AWR Basin, including the results of the 1970 population census. This projection of water use was used for the projection of the extent of future irrigated crop acreage.

To form an idea of the future level of agricultural earnings, and employment and the future level of activity in local industries affected by agricultural activity, it is necessary to make estimates of future agricultural production and land use. In an analysis of what effects will ensue from certain contemplated USDA investments in natural resources conservation and/or development, it is usually first necessary to estimate what will happen to agricultural production and land use in the event that USDA programs simply remain at their status quo level. Often, such estimates indicate that increasing production and resource development will occur in the future even without any change in the ongoing USDA program levels. To take such estimates into account is an aid in preventing an exaggerated estimate of the future effects of contemplated USDA program additions and/or accelerations.

TABLE 4-18. PROJECTED WATER DEPLETION DEMAND BY USES, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Use	Depletion Demand 1/ 1980	2000	2020
	1000 Acre-Feet		
Urban	2.1	3.5	5.6
Rural domestic	1.0	1.1	1.4
Irrigation	229.5	235.3	256.9
Manufacturing	.1	.3	.4
Minerals	1.2	4.0	10.8
Livestock	15.3	16.7	16.9
Power	.2	14.6	68.5
Fish & Wildlife	10.5	11.2	11.2
Recreation	0	0	0
Reservoir evaporation	74.5	76.8	76.8
TOTAL	334.4	363.5	448.5

Source: U. S. Bureau of Reclamation, Water Resources Assessment, 1976.

1/ Depletion demand projections are based on regional population projections made by BBR, which utilized 1972 state population projections from the U. S. Bureau of Economic Analysis as a source.

The projections of future agricultural production mentioned below are based upon the past local trends of individual crop acreages. (Appendix E includes a detailed explanation of the projections.)

The projections based upon past crop acreage trends were teamed with projections of local crop yields developed by the AWR Basin Study Field Staff to arrive at projections of local production. The method of making agricultural projections of future conditions, without a basin plan, is essentially an extension of past trends in acreages of the major crops by counties. This was modified by the projected supply of irrigation water as related to the expected future demands for water in competing uses. Table 4-19 shows the projected irrigated acreage from ground and surface water sources after satisfying projected nonagricultural demand.

TABLE 4-19. PROJECTED IRRIGATED ACREAGE FROM SURFACE AND GROUND WATER SOURCES REMAINING AFTER SATISFYING PROJECTED NONAGRICULTURAL DEMAND 1/ - ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Year		Acres 1969	1980	2000	2020
AWR Total		124,250	162,720	161,540	176,520
Colfax	ground	1,000	920	920	870
	surface	25,370	21,000	18,920	15,990
	total	26,370	21,920	19,840	16,860
Curry	ground	17,780	20,000	0	0
	surface	0	0	0	0
	total	17,780	20,000	0	0
Harding	ground	4,210	9,300	13,100	13,200
	surface	0	0	0	0
	total	4,210	9,300	13,100	13,200
Mora	ground	0	0	0	0
	surface	12,600	12,920	12,220	11,660
	total	12,600	12,920	12,220	11,660
Quay	ground	2,350	4,240	11,080	15,310
	surface	28,270	34,070	34,080	34,000
	total	30,620	38,310	45,160	49,310
San Miguel	ground	150	0	0	0
	surface	3,050	3,280	3,310	3,400
	total	3,200	3,280	3,310	3,400
Union	ground	25,040	52,780	63,730	77,950
	surface	4,430	4,210	4,180	4,140
	total	29,470	56,990	67,910	82,090

Source: Unpublished estimate, based on OBERS 1968 projections, by State Engineer Office, New Mexico, 1977.

1/ Excludes nuclear power plants in Mora and Union Counties

After projections of crop acreages were obtained, they were translated into agricultural production by means of yield projections developed by the Economics, Statistics, and Cooperatives Service and Soil Conservation Service. (See Table 4-20.) These yield projections utilize a process which smoothes the past trend and then extends it into the future.

The expected level of agricultural development in future years without new public programs is shown in Table 4-21. In this framework, the existing and on-going projects and programs, to a large extent, are considered part of expected future conditions. The conditions described include projections of production, employment, income, water requirements, and land requirements.

Nature of Projected Changes

The amount of irrigated acreage is projected to show a net increase from 155,800 in 1974, to 162,720 in 1980, and 176,520 in 2020. The land presently being converted to irrigation is mainly former rangeland that has not been dry-cropped. The water source is newly tapped groundwater supplies. Future irrigation development is expected to continue the trend of conversion of rangeland through development of ground water sources.

A decrease is projected for cropland presently irrigated by means of mining water from a declining groundwater reservoir. The extent and location of this projected decrease are 20,000 irrigated acres in Curry County between 1980 and 2000. The affected irrigated land is expected to revert back to the dry cropland category, but not necessarily to increase the future annual amount of dry cropland harvested.

TABLE 4-20. PROJECTIONS OF CROP YIELDS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Crops		1980	2000	2020
		Units per acre		
Irrigated crops				
Cotton	(bales)	.69	.92	1.15
Barley	(bu.)	50	67	78
Corn, grain	(bu.)	114	143	163
Corn, silage	(tons)	16	20	25
Sorghum, grain	(bu.)	78	99	117
Sorghum, Silage	(tons)	17	21	25
Wheat	(bu.)	41	55	75
Alfalfa	(tons)	4.5	5	5.4
Other hay	(tons)	1.5	1.7	1.8
Dryland crops				
Sorghum, grain	(bu.)	19	31	39
Sorghum, silage	(tons)	7.3	9.2	11.2
Wheat	(bu.)	15	19	22

Sources: (1) USDA Statistical Reporting Service and New Mexico Department of Agriculture; New Mexico Agricultural Statistics, Series 1959-73.

(2) USDA Soil Conservation Service and Economics, Statistics, and Cooperatives Service, joint estimates of future yield levels made by members of the AWR Basin Study field-party staff.

TABLE 4-21. PROJECTIONS OF CROPLAND USE AND PRODUCTION, 1980, 2000 AND 2020 WITHOUT INCREASED USDA PROGRAM, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

CROPS	1980 LAND AREA (Acres*)	1980 PRODUCTION (Specified Units)	2000 LAND AREA (Acres*)	2000 PRODUCTION (Specified Units)	2020 LAND AREA (Acres*)	2020 PRODUCTION (Specified Units)
Irrigated Crops						
Cotton	1,050	720 bales	0	0	0	0
Barley	2,230	111,580 bu. 1/	2,380	159,400 bu. 1/	2,540	198,360 bu. 1/
Corn, grain	7,390	842,580 bu.	12,910	1,849,110 bu.	16,910	2,758,190 bu.
Corn, silage	8,380	134,000 tons	7,070	141,400 tons	8,940	223,500 tons
Sorghum, grain	18,240	1,413,970 bu.	14,420	1,271,840 bu.	17,380	2,024,770 bu.
Sorghum, silage	6,110	103,870 tons	1,330	27,930 tons	1,240	31,000 tons
Wheat	18,950	777,750 bu.	19,650	1,089,450 bu.	23,920	1,783,470 bu.
Alfalfa hay	24,720	100,980 tons	25,730	118,880 tons	26,440	133,520 tons
Other hay	18,730	26,410 tons	15,550	24,720 tons	16,670	28,420 tons
Other harvested crops 1/	3,340		3,820		3,820	
Irrigated pasture 2/	53,580		58,680		58,620	
Total Irrigated Crops 3/	162,720		161,540		176,520	
Dryland Crops						
Sorghum, grain	28,320	539,600 bu.	28,320	890,240 bu.	28,320	1,107,880 bu.
Sorghum, silage	14,050	102,780 tons	8,000	73,560 tons	6,790	75,790 tons
Wheat	123,900	1,805,220 bu.	128,520	2,375,050 bu.	131,960	2,953,920 bu.
Other dry crops 1/	730		2,200		1,130	
Total Dry Crops	167,000		167,040		168,200	
Cropland unharvested 4/	360,790		360,750		359,590	
Total dry cropland 5/	527,790		527,790		527,790	

* To convert to hectares, multiply by 0.4047.

1/ Utilizes OBERS projections, Series E'.

2/ Irrigated pasture acreage figures are residual amounts equal to the difference between total projected irrigated land acreage planted in harvest crops and projections based on New Mexico State Engineer estimates of water depletion by irrigation.

3/ Based on New Mexico State Engineer estimates of depletion, unpublished.

4/ Includes fallow, idle, and crop-failure acreage, plus land in cover crops, legumes and soil-improvement grasses.

5/ Assumed to remain at 1974 level through year 2020.

Sources:
1. USDA, Statistical Reporting Service and New Mexico Dept. of Agriculture New Mexico Agricultural Statistics, Series 1959-1974.
2. Unpublished information from USDA field specialists stationed in the Arkansas-White-Red River Basin study area, New Mexico.
3. New Mexico River Basins Staff, USDA; unpublished projections of future crop yields.
4. New Mexico State Engineer Office; unpublished projections of irrigation water availability.

The extent of dry cropland harvested annually is projected to rise to 167,000 acres in 1980 from 99,000 acres in 1974 and to remain almost unchanged through Year 2020.

Livestock production projections are shown in Table 4-22. Cattle production is by far the most significant portion of agricultural production and accounted for about 90 percent of the agricultural sales in recent years. Projecting future beef production that would occur, without improved resource development and management systems, was accomplished by estimating to what extent local rangeland resources will accommodate the expected future demand for beef and veal under the existing, ongoing USDA programs for rangeland conservation and beef-herd management. Projections of other types of livestock production were obtained from U. S. Water Resources Council OBERS Series E' unpublished backup materials.

TABLE 4-22. PROJECTED LIVESTOCK PRODUCTION, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO (IN THOUSANDS OF UNITS)

Products	1969	1980	1990 1/	2000	2020
Beef and veal, lb.	139,260	206,789	207,771	208,753	208,730
Pork, lb.	3,182	4,074	4,089	4,105	3,723
Lamb and mutton, lb.	959	393	326	259	288
Chickens, lb.	20	143	165	186	219
Turkeys, lb.	35	11,546	5,773	0	0
Eggs, doz.	433	1,091	1,251	1,412	1,663
Milk, lb.	23,782	14,269	15,220	16,172	19,026

Sources: (1) U. S. Water Resources Council, OBERS Series E' unpublished estimates.
(2) U.S. Census of Agriculture, 1969.
(3) New Mexico Agricultural Statistics, 1973-75.
(4) New Mexico SEO unpublished projections of irrigated cropland.

1/ By interpolation between 1980 and 2000 projected values.

FUTURE MINING

Coal

The mining of coal in the basin will be little affected by programs implemented by the Department of Agriculture. The demands of the steel industry will determine changes in coal production. Kaiser Corporation controls almost all of the coal reserves in the basin.

Kaiser has estimated reserves of about 715 million tons of high grade coking coal. Coal production is expected to increase slightly in the future.

Carbon Dioxide: The carbon dioxide industry in Harding County will be little affected by programs implemented by the Department of Agriculture. In other areas of the United States, CO_2 is produced using natural gas. Demand for CO_2 from the SEC Plant at Sofano, New Mexico increased sharply during the natural gas shortage in the winter of 1976-77. Demand could remain high in the future if natural gas remains in short supply.

Sand and gravel: The use of sand, gravel, caliche, scoria, and volcanic rock will not be affected by programs of the Department of Agriculture. A reduction is expected in the use of sand and gravel with the completion of the interstate highway system.

SOCIO-ECONOMIC PROJECTIONS

The projected value of agricultural production, without plan, is shown (in 1976 dollars) in Table 4-23. An estimate of future agricultural earnings, based on projected production, is also shown in Table 4-23.

The earnings projections differ from the U. S. Water Resources Council's OBERS projections of agricultural earnings because the agricultural output differs between the OBERS projections and without-plan projections.

Agriculture, and especially beef production, is a basic industry of the basin, exporting products to the rest of the nation. The sizes of certain other local industries (the service industries) are related to the size of agriculture and to the size of other basic industries such as mining and most manufacturing.

TABLE 4-23. PROJECTED GROSS VALUE OF AGRICULTURAL PRODUCTION AND EARNINGS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Product	1980	1990 1/	2000	2020
	Thousands of 1976 dollars			
Beef and veal	90,226.4	90,654.8	91,083.1	91,073.1
Pork	1,408.7	1,414.1	1,419.6	1,287.5
Lamb and mutton	128.9	106.8	84.8	94.3
Chickens	20.7	24.0	27.1	31.9
Turkeys	4.4	2.2	0	0
Eggs	734.7	842.7	950.6	1,119.7
Milk	1,558.3	1,662.0	1,765.9	2,077.5
TOTAL livestock	94,082.1	94,706.6	95,331.1	94,684.0
Cotton	169.4	84.6	0	0
Barley	242.1	294.0	345.9	430.4
Corn, grain	2,317.1	3,704.8	5090.2	7,592.7
Corn, silage	1,608.0	1,652.4	1,696.8	2,682.0
Sorghum, grain	4,883.9	5,144.6	5,405.2	7,831.6
Sorghum, silage	1,246.4	790.8	335.2	372.0
Wheat	8,601.3	10,069.0	11,536.8	15,775.6
Alfalfa	5,203.5	5,664.7	6,125.9	6,880.3
Other hay	1,360.9	1,317.5	1,273.8	1,464.5
Other crops	207.4	218.6	229.7	254.8
TOTAL Crops	25,840.0	28,941.0	32,039.5	43,283.9
TOTAL agriculture	119,922.1	123,647.6	127,370.6	137,967.9
Agricultural earnings	46,982.8	43,287.0	39,592.1	51,898.7
Employment (1000's)	2,040	1,540	1,040	830

1/ Interpolation estimates.

Sources: (1) U.S. Census of Agriculture, 1969.
(2) OBERS Projections, Series E'; unpublished supporting data.
(3) Agricultural Statistics, USDA; Series 1967-1975.

The U. S. Water Resources Council's Series E' OBERS projections of agricultural activity differ from the without-plan projections. The latter are considered to be more realistic projections of future agricultural activity. Therefore, they were substituted for the OBERS agricultural projections, and the OBERS service-industry projections were altered to reflect the fact that agricultural activity affects the level of the service industries' activity.

Production-based inter-industry multiplier coefficients developed in 1972 by U. S. Forest Service and ESCS personnel* for a neighboring region of similar size were used to relate agricultural activity to service-industry activity. Thus, the service-industry earnings of OBERS Series E projections were treated as a base from which to derive new values based on the without-plan projections of agricultural output. (See Tables 4-24 and 4-25.) References to Series E' agricultural production projections in one portion of the analysis were compatible with the use of Series E projections as a base for without-plan projections of income and employment in the service industries.

Government's level of activity was assumed to be essentially independent of the level of agricultural activity at the magnitudes seen in Tables 4-24 and 4-25.

Mining, one of the main basic industries, was not considered to be dependent on the level of agricultural activity. However, part of the manufacturing activity (food processing) was treated in similar fashion as the service industries here, as its size is very dependent upon the level of agriculutral activity.

Alternative projections of earnings and employment in the basin's service industries, without USDA plan, were obtained (See Table 4-26). These projections were based upon the unpublished 1977 population projections made by the Bureau of Ecnomic Analysis (BEA), unlike Table 4-24 without-plan projections of basin earnings and employment in the service industries.

*See U. S. Department of Agriculture, Forest Service, and Economic Research Service, <u>Evaluation of Economic Impact of Forest Service Programs in Northern New Mexico</u>, 1968.

TABLE 4-24. PROJECTED INDUSTRY EARNINGS AND EMPLOYMENT, WITHOUT USDA PLAN, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Industry	1980	1990 1/	2000	2020
	In thousands of 1976 dollars			
Earnings				
Agriculture	46,983	43,288	39,592	51,899
Mining	4,455	5,662	6,869	9,839
Manufacturing	11,231	18,399	25,567	52,478
Contract construction	2,828	3,829	4,830	7,664
Transportation, comm. & public utilitiies	10,190	12,132	14,074	20,935
Wholesale & retail trade	20,038	23,111	26,183	34,283
Finance, insurance & real estate	8,663	13,330	17,998	33,604
Services	17,221	22,606	27,992	43,738
Government	39,809	58,644	77,479	139,548
TOTAL	161,418	201,001	240,584	393,988
Employment	In numbers employed			
Agriculture	2,040	1,540	1,040	830
Mining	320	305	290	240
Manufacturing	820	950	1,080	1,270
Contract construction	240	245	250	240
Transportation, comm. & public utilities	690	635	580	520
Wholesale & retail trade	2,300	2,070	1,840	1,450
Finance, insurance & real estate	790	895	1,000	1,130
Services	2,970	2,960	2,950	2,790
Government	2,920	3,095	3,270	3,400
TOTAL	13,090	12,695	12,300	11,870

Sources: (1) USDA, Statistical Reporting Service and New Mexico Dept. of Agriculture, New Mexico Agricultural Statistics, Series 1959-1974.
(2) U. S. Dept. of Commerce, Growth Patterns in Employment by County, 1940-50 and 1950-60.
(3) U. S. Census of Population, 1970
(4) U. S. Water Resources Council, OBERS Projections, and OBERS supporting data, Series E.
(5) Projections are based on procedures outlined in Chapter 4 text.

1/ Interpolation estimates

TABLE 4-25. PROJECTED INDUSTRY EARNINGS AND EMPLOYMENT, OBERS SERIES E, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Industry	1980	1990 1/	2000	2020
	In thousands of 1976 dollars			
Earnings				
Agriculture	50,858	53,544	56,229	69,906
Mining	4,455	5,662	6,869	9,839
Manufacturing	11,524	19,176	26,827	53,841
Contract construction	2,836	3,847	4,861	7,697
Transportation, comm. & public utilities	10,203	12,165	14,127	20,994
Wholesale and retail trade	20,051	23,143	26,237	34,342
Finance, insurance & real estate	8,672	13,355	18,038	33,648
Services	17,248	22,677	28,108	43,866
Government	39,809	58,644	77,479	139,548
TOTAL	165,656	212,213	258,775	413,681
Employment	In Numbers Employed			
Agriculture	2,210	1,850	1,480	1,110
Mining	330	310	290	240
Manufacturing	840	990	1,130	1,310
Contract construction	210	210	200	190
Transportation, comm. & public utilities	750	670	600	510
Wholesale and retail trade	1,470	1,290	1,110	840
Finance, insurance & real estate	640	700	760	820
Services	1,260	1,230	1,190	1,070
Government	2,920	3,100	3,270	3,400
TOTAL	12,130	10,350	10,030	9,490

Sources: (1) U. S. Water Resources Council, OBERS Projections and OBERS supporting data.
(2) U. S. Department of Commerce, Growth Patterns in Employment by County 1940-1950 and 1950-1960.
(3) U. S. Census of Population, 1970.

1/ Interpolation estimates

TABLE 4-26. PROJECTED INDUSTRY EARNINGS AND EMPLOYMENT, WITHOUT USDA PLAN, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO (WITH BEA 1977 POPULATION)

Industry	1980	1990 1/	2000	2020
	In Thousands of 1976 Dollars			
Earnings				
Agriculture	46,983	43,288	39,592	51,899
Mining	4,455	5,662	6,869	9,839
Manufacturing	16,702	29,970	43,238	95,363
Contract construction	5,072	6,210	7,349	13,168
Transport, comm., & public utilities	18,837	23,065	27,293	48,863
Wholesale and retail trade	34,085	41,736	49,386	88,392
Finance, insurance, & real estate	10,767	17,923	25,080	50,814
Services	29,307	35,885	42,464	76,047
Government	49,761	79,116	108,470	212,114
TOTAL	215,969	282,855	349,741	646,499
Employment	In Numbers Employed			
Agriculture	2,040	1,540	1,040	830
Mining	330	310	290	240
Manufacturing	1,230	1,455	1,680	1,910
Contract construction	420	400	380	400
Transport, comm., & public utilities	1,270	1,195	1,120	1,210
Wholesale and retail trade	3,910	3,690	3,470	3,740
Finance, insurance, & real estate	980	1,190	1,400	1,710
Services	5,060	4,770	4,480	4,850
Government	3,650	4,115	4,580	5,160
TOTAL	18,890	18,665	18,440	20,050

Sources: (1) USDA, Statistical Reporting Service and New Mexico Dept. of Agriculture, New Mexico Agricultural Statistics, Series 1959-1974.
(2) U. S. Dept. of Commerce, Growth Patterns in Employment by County, 1940-50 and 1950-60.
(3) U. S. Census of Population, 1970.
(4) U. S. Water Resources Council, OBERS Projections, and OBERS supporting data, Series E.
(5) U. S. Bureau of Economic Analysis; unpublished population projections for the Arkansas-White-Red River Basin, 1977.

1/ Interpolation estimates

The projected industry differences for earnings and employment between the OBERS Series E projections and the projections based on AWR crop-acreage trends are generally small. The main differences to be noted are in agriculture and in manufacturing. The explanation for the large difference for manufacturing earnings and employment is that the crop and livestock processing sector of manufacturing was greatly affected in the projections process by the agricultural production difference obtained by the two different projections approaches.

Because mining is a basic industry whose size is not logically affected by changes in local agriculture, its size in the projections based on crop-acreage trends was not projected to differ from its OBERS projection size.

OUTDOOR RECREATION AND RELATED ECONOMIC ACTIVITY

The Arkansas-White-Red River Basin has lands suited for a variety of outdoor recreation activities. The higher elevations provide climatic relief for summer visitors. There are good opportunities for fishing, camping, hiking, and sightseeing. In the fall and winter the mountains provide big game hunting, skiing, and snowmobiling. Conchas and Ute Reservoirs, Clayton Lake, and other smaller impoundments offer water-based recreation. Geological and historical sites offer the tourist a variety of other attractions.

The following table shows the outdoor recreation land in the basin.

TABLE 4-27. OUTDOOR RECREATION LAND OWNERSHIP, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Ownership	Developed Acres	Undeveloped Acres	Lake Acres
Federal	865	179,546	17,235
State	2,060	42,417	910
County	50	30	0
Municipal	194	663	150
Private	775	1,128,010	2,950
TOTAL	3,944	1,350,666	21,245

Source: Recreation Resources in New Mexico, State Planning Office, 1975, and SCS field personnel.

With 85 percent of the basin in private ownership, the private recreation sector is recognized as fulfilling a significant portion of the total spectrum of recreation supply. There are large tracts of private forest land which are ideally suited for both developed and undeveloped outdoor recreation. Some of these private lands are presently being utilized for fee hunting, fishing, and camping.

A variety of landscapes and a wide range of climate provide varied and plentiful recreational opportunities. Mountains in the western portion of the basin offer hunting, fishing, camping, and skiing.

It is estimated that in 1975 there were 260,000 visitor days use of community type recreation developments, (ball fields, tennis courts, and golf courses) and 380,000 visitor days use of all other facilities (picnicking, camping, fishing, hunting and skiing).

Based on the _1975 Outdoor Recreation Survey for New Mexico Residents_, the three most popular outdoor recreation activities in the Arkansas-White-Red River Basin are those which do not require special facilities. These are bicycling, pleasure walking, and jogging. The most popular activities requiring facilities are: pool swimming, park visits, tennis, baseball, fishing, and picnicking. (See Table 5-4, Chapter 5.)

The primary goal for outdoor recreation in New Mexico is to provide a balanced system of outdoor recreation opportunities, easily accessible, for all citizens of the state. To accomplish this goal, all levels of government must assume the responsibility for implementing plans and programs within their respective jurisdiction.

The state, through appropriate agencies, will assume the major leadership responsibility in coordinating the efforts of all levels of government in providing outdoor recreation opportunities.

A 1973 State Outdoor Recreation Act created the State Supplemental Fund to assist small communities (15,000 or less population) with 25 percent of the total cost of a federally funded project through the Land and Water Conservation Fund Program.

One of the most important problems encountered in recreation planning involves preserving the environment. New Mexicans are aware of the increasing number of ecological problems and diminishing quality of some of the natural resources in the state. Vigorous efforts are being directed toward solving these problems in a comprehensive manner to achieve and maintain a quality environment. It is apparent that past efforts were often unplanned, uncoordinated, and sometimes enacted with little regard for the consequences.

Outdoor recreational visits create considerable income to some of the communities in the basin. Expenditures per visitor day vary with each type of recreation activity.

Increasing leisure time, income, and mobility are expected to increase outdoor recreation activities of all people. The basin will feel this increase in the form of more visitors. Landowners and land management agencies should consider the opportunities for dispersed and developed recreation when selecting land management alternatives.

Table 4-28 shows the projected recreation demand from Arkansas-White-Red River Basin residents. However, when the demand from New Mexico out-of-basin and out-of-state is added, the total demand will exceed the capacity of some facilities.

TABLE 4-28. 1975 AND PROJECTED DEMAND IN VISITOR DAYS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Activity	1975	1980	1990
Water-Based 1/	98,400	112,700	143,100
Active 2/	1,810,200	2,124,200	2,655,600
Passive 3/	350,200	395,300	465,800
Winter 4/	15,100	17,300	19,500
TOTAL (rounded)	2,273,900	2,649,500	3,284,000

Source: Recreation Resources in New Mexico, State Planning Office, 1975; SCS field personnel; and, 1975 Outdoor Recreation Survey for New Mexico Residents.

1/ Water-based includes fishing, boating, swimming, and water skiing.
2/ Active includes camping, hunting, bicycling, horseback riding, outdoor sports and games, walking, hiking, mountain climbing, and nature walks.
3/ Passive includes picnics, driving, sightseeing, and attending outdoor sports, events, and concerts.
4/ Winter sports includes ice skating, snow skiing, sledding, snowmobiling and tobogganning.

FOREST RESOURCES AND RELATED ACTIVITY

Utilization, Volume, and Value of Output

The goal in forest resource management is to establish a sustained yield of timber and other wood products while enhancing wildlife habitat, recreation opportunities, forage for livestock, and the supply and quality of water for instream and downstream uses. To meet the goal, timber stands must be grown and harvested according to their silvicultural requirements and in a manner which does not cause adverse impacts on other resources and uses. At the present time, industry is largely oriented toward sawlog production. Other products include posts, corral and utility poles, house logs, and mining timber.

PHOTO 4-4. Dead Aspen trees from the Eagle Nest area are utilized for excelsior. This load was headed to El Paso, Texas.

At the present time, the estimated annual allowable cut for the basin is 120 million board feet. The harvest in 1974 was about 20 million board feet, which was valued at about $631,000. It is estimated that 5 percent of the volume harvested is utilized within the basin. Nearly two-thirds of the state's exports were shipped to adjacent states (New Mexico Agricultural Experiment Station, 1965).

Landownership of commercial forest land in the Arkansas-White-Red River Basin is: 87 percent private, 8 percent state, and 5 percent federal.

Potential harvests of timber from the private lands is dependent on (1) prospective economic operability of timber inventories at different price levels, and (2) the owners' willingness to sell their timber.

In most instances, the primary source of revenue received from the privately owned forest lands is not from wood products but from livestock grazing, wildlife fee hunting, developed outdoor recreation, and fishing.

While there are many technical and economic opportunities for increasing timber growth and harvest, ownership constraints tend to limit practical increases in timber supply. The long investment period and relatively low rates of return for most forestry practices are significant barriers to intensified management by most private owners.

As a result of past timber harvests, the logs presently going into the sawmills are from small residual trees and second growth trees. Sawmill managers report that the average 16-foot log is 11 inches in diameter or about 70 board feet in volume. This size of log is very marginal for utilization as lumber.

Timber harvesting responses to increased prices appear to vary among different owners. Some private owners willingly increase timber sales as prices rise, whereas other private owners hold forest land and timber for non-timber purposes, and have little or no interest in selling timber even at relatively high prices.

The following projections for the Arkansas-White-Red River Basin are based on 1972 OBERS data, Volume 1, page 109.

TABLE 4-29. PROJECTED FOREST AREA AND PRODUCTION OF FOREST PRODUCTS ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

	Year				
	1972	1974	1980	2000	2020
Commercial Forest Area (1000 acres)	1250	1236	1226	1216	1204
Roundwood Production (Million Cubic Feet)	.14	.50	.76	1.08	1.23
Sawlog Production (Million Cubic Feet)	.92	3.40	5.08	7.02	7.02
Pulpwood Production (Million Cubic Feet)	.0	.0	.0	1.68	2.90

Source: 1972 OBERS projections.

Employment and Income

Forest resource related activities include managing the forest, timber harvesting, primary and secondary manufacturing, building, transportation, and marketing. Employment fluctuates with the demand for products and the season.

Forest industries have been an important part of the economy of the small communities in Western Colfax, Mora, and San Miguel Counties.

In 1950 there were 35 sawmills in the basin. Total employment in the logging and lumbering industries was 395.

In 1974 there were nine small sawmills. These are family operations employing only two to four persons each. There were two medium sawmills in operation in 1974 which employed about 40 persons each. Total employment in the logging and lumbering industries was approximately 290.

CHAPTER 5

Water And Related Land Resource Problems

This chapter covers the causes, extent and frequency, and the economic and social consequences of the water and related land resource problems. The results of the studies are summarized in physical and monetary terms covering the following topics: General Agriculture, Flood Damage, Erosion, Land Use Planning, Impaired Drainage, Water Depletion and Limitation, Wildfire, Fish and Wildlife, Outdoor Recreation, and Pollution.

CHAPTER 5 WATER AND RELATED LAND RESOURCE PROBLEMS

TABLES

FIGURES

MAPS

G E N E R A L   A G R I C U L T U R A L

The role of agriculture in the economy of the basin is changing; but in relation to the utilization of the natural resources--namely, land and water--agriculture continues to be of major importance. Significant changes are taking place in the structure of the economy, but agriculture's contribution to the gross product of the basin remains about the same, with the major components of agricultural enterprise being livestock and livestock products. Other important cash producing crops are hay, sorghum grains, and wheat. There is a substantial quantity of dryland farming, but the cash return from this source comprises only a small part of the total.

A continuing program of soil and water conservation is necessary to prevent deterioration of the resource base. Especially urgent is the need to protect cropland, rangeland, and the forests from erosion.

CROPLAND MANAGEMENT

The type of farming in the irrigated areas varies with available water supply, elevation, and climatic conditions. There is a need to select the best lands suitable for irrigation and to improve irrigation practices for maximum water use efficiency. In some areas the major problems are securing sufficient water for crop production, improving conveyance systems and improving irrigation efficiency. Much information is available at present which, if put into effect on the farms, would result in a considerable saving in the present supplies of irrigation water available to the farmers.

Field irrigation trials and demonstrations can be a valuable tool to demonstrate to the local farmers the importance of using proper irrigation water management. This program could be used to obtain data on the irrigated areas in the basin and would permit more accurate recommendations for the types of irrigation systems to be used.

The lack of moisture limits kinds of crops and yields on nonirrigated cropland. During many years, crops do not produce economic returns. Residue produced does not provide adequate ground cover for control of wind and water erosion. Abandoned cropland is subject to high erosion from wind and water because of poor stands of vegetative cover. The poor vegetative stands with low forage value also limits economic return to the operator.

In order to effectively carry out the existing programs, more time and emphasis needs to be spent on all phases of the present educational program.

RANGE MANAGEMENT

Historically, the native rangeland has been heavily grazed. The ranges have deteriorated to the point that the production is only a portion of what was once produced or of what they are capable of producing. Over use and improper seasonal use, compounded by erratic precipitation and fragile soils, accounts for accelerated erosion in some areas.

Range condition is measured by the general condition of the present vegetation as compared to the potential for the site. Vegetative density is inadequate in many areas to protect the soil from wind and water erosion; productivity decreases, runoff increases, channels erode wider and deeper, and the water tables go lower. Stabilization of the soil, the foundation for sustaining the forage resource, is a prime problem. Some areas of critical erosion needing control are marginally suited grazing lands.

Progress in solving range problems is slow because of the limited acceptance, application, and follow-through of improved grazing systems. Continuous grazing has eliminated cool-season grasses in many areas of the basin. Because of this, a monoculture range has developed which is dominant in warm-season grasses. This results in frequent shortages of forage in the spring which, in some years, is compounded by a lack of precipitation. The erratic occurrence of precipitation has a direct bearing on many ranchers' willingness to invest in the cost of range improvement.

There are about 8.1 million acres of range and pasture land. The rates of livestock use of this land range from about 3.2 acres per animal unit month (AUM) to about 70 acres per AUM. Part of the high acreage requirement per AUM is due to geographical location and to season of use. Other reasons are related to past and continuing overuse of the range brought about by economic pressures and lack of complete understanding of plant growth requirements. Constant use has reduced the vigor of or eliminated many desirable forage plants, and they are being replaced by junipers, pinyon, pingue, snakeweed, and less desirable grasses and annuals. Some of the undesirable species are toxic. Recovery through improved management practice is likely to be slow. Success of reseeding is low in many areas of the basin because of soil and climatic limitations. The exclusion of livestock, for two to three growing seasons, is needed for plant establishment, but this creates an economic burden on the owner. Problems of how to supplement incomes during the restoration period are difficult to solve.

FOREST MANAGEMENT

There are about 1.2 million acres of commercial timber lands. These lands have the capability of growing at least 20 cubic feet per acre of timber per year. Maximum wood products from forest lands are not being obtained with the present level of forest management. Small landowners generally cannot afford to invest in reforestation and other practices that will increase future timber yields.

Private landowners usually do not obtain the highest price for their forest products. They also lack the knowledge and/or incentive to obtain maximum utilization of the products as they are harvested in the woods.

Competition among the alternative uses for timber lands and satisfying environmental consideration in management have imposed new problems. Other problems affecting the forest resources include the high cost of road construction, market locations, location of transportation hubs in relation to sawmills, and the high investment for equipment and supplies.

FLOOD DAMAGE

FLOODWATER

Intensive summer thundershowers are the principal causes of floodwater and sediment damage.

Average annual flood damage is estimated to be about one million dollars. Although flood damage occurs on all of the watersheds, major physical and monetary damage occurs where land in the floodplain has been developed for irrigation or is in urban use. Significant flood damage or loss on most watersheds begins with runoff produced by the ten percent chance of occurrence flood.

The principal areas of flood damage to agricultural property include the floodplains of the Dry Cimarron River, Chico Rico Creek, Vermejo River, Cimarron Creek, Mora River, and the Canadian River above U.S. Highway 64. Flood damage is not a serious problem on irrigated lands in the Tucumcari irrigation project. There is some damage from floods to the main irrigation supply canal, which is operated and maintained by the Arch Hurley Conservancy District.

Nonagricultural flood damage in the basin includes urban property, utilities, and transportation facilities. Principal areas of urban damage are the Town of Springer and the Village of Cimarron from floods originating on Cimarron Creek and tributaries, and the Town of Mora from the Mora River. There is minor flood damage in Raton and Tucumcari, primarily from interior drainages. The Raton municipal water storage reservoirs and pipeline are damaged from floods in the Chico Rico Watershed.

PHOTO 5-1. Flood damage, Dry Cimarron River Valley Bridge, 1955

Transportation facilities damaged by floods include highways, railroads, and roads. Major or unusual floods, such as the June 1965 flood, damaged major highways, bridges, county and private roads, and the railroad. In June 1965, ten bridges on six highways were severely damaged, and the Santa Fe Railroad incurred damage which delayed traffic. County roads are damaged more often from much smaller floods.

P6-3

PHOTO 5-2. Flood damage, Carrizo Creek, 1937

Flood damage on watersheds where there is no land developed for irrigation or no urban development in the floodplain occurs fairly frequently. However, the monetary damage or loss is not highly significant when viewed as a basin problem, but is of local significance to property owners. Floods damage erosion control dams, dikes, levees, stock ponds, and fences, as well as other on-farm or ranch improvements. Indications are that the greatest single damage is the erosion of the land itself, with a subsequent deposition of sediment in channels, on the floodplains, and in downstream reservoirs.

Field investigations and interviews with property owners and other contacts with local people were made on twenty-six watersheds in the basin. Some of the flood damage information was gathered prior to the start of the basin study. This information included preliminary investigations and field examinations made on the Dry Cimarron River, Upper Mora River, Chico Rico Creek, Carrizozo Creek, and the Vermejo River. These early investigations were made to assess the feasibility of potential watershed projects under Public Law 566. Flood damage data gathered in the earlier investigations have been updated to current normalized prices for agricultural property and current prices for nonagricultural property.

PHOTO 5-3. Flood damage, Dry Cimarron River, 1955

Table 5-1 shows the estimated average annual flood damage on the twenty-six watersheds studied. In addition, an overall judgment estimate was made for average annual flood damage on the remaining watersheds in the New Mexico portion of the basin. The total flood damage estimate includes floodwater, erosion, and sediment damage. In most cases, the intensity of the survey precludes monetary separation of damage into three categories, i.e., floodwater, erosion, and sediment.

TABLE 5-1 ESTIMATED AVERAGE ANNUAL FLOOD DAMAGES
ARKANSAS-WHITE-RED-RIVER BASIN, NEW MEXICO

Name of Watershed or Drainage	Estimated Average Annual Flood Damage - Dollars 1/
Sapello River	26,900
Mora River	71,300
Cimarron Creek	83,000
Rayado Creek	20,600
Ponil Creek	11,500
Van Bremmer Creek	2,000
Vermejo River	60,100
Canadian River (Main Stem)	23,600
Chico Rico Creek	142,600
Dry Cimarron River	212,000
Carrizozo Creek	12,800
Corrumpa Creek and North Canadian River	10,000
Cienequilla Creek	4,100
Perico Creek	3,000
Carrizo Creek	7,500
Major Long Creek	6,000
Monia Creek	7,000
Bueyeros Creek	6,000
Tequesquite Creek	5,000
Ute Creek	25,000
Mosquero Creek	4,000
La Cinta Creek	7,500
Trementina Creek	5,000
Conchas River	10,000
Garita Creek	2,000
Frio Draw	3,000
Subtotal - 26 watersheds	771,500
Remaining watersheds in New Mexico portion - AWR	175,000
TOTAL Average Annual Flood Damage	946,500

Source: River Basin Planning Staff

1/ Price base: Current normalized for agricultural-1975 for nonagricultural. (Current normalized prices for the agricultural sector are prepared by the Economics, Statistics and Cooperatives Service and published by the Water Resources Council. The prices are a five-year weighted average of actual season prices. The prices used in this study are for the period 1970-1974 and were published November 26, 1975.)

EROSION

Erosion can be the result of physical elements, such as poor soil characteristics, inadequate vegetative cover, steep slope, excessive precipitation, and strong wind. It is estimated that between 6,900 to 13,800 acre-feet of soil are eroded by water each year. Erosion rates vary from less than 0.1 to more than 2.0 acre-feet per square mile annually.

Erosion rates were computed using vegetation associations in determining the cover factor. These computations indicate there are about 3,920 square miles in the basin eroding at an average of between one and two acre-feet per square mile annually, about 1,600 square miles eroding at between 0.5 and 1.0 acre-feet per square mile annually, and 12,202 square miles which erode at less than 0.5 acre-feet per square mile annually.

The present erosion rates (includes sheet, rill, gully, and streambank) are shown on the Erosion Rates Map. This erosion rate is expected to continue unless better management is practiced.

Erosion is primarly related to land use and vegetative conditions. The land use and how well the vegetative cover is maintained dictates the amount of soil lost. Vegetative cover is one of the important elements affecting soil losses and is influenced directly by land management practices.

Sheet and gully erosion is a serious problem on the areas of the grazing lands adjacent to the escarpments, canyons, breaks, and along the pinyon-juniper foothills. Erosion was caused in many cases by cattle trails and past heavy use and remains a constant threat to environmental quality. These areas are relatively limited in the basin; however, they do produce a significant amount of sediment that is deposited in the streams and reservoirs.

Gully and channelbank erosion are excessive in many areas. Raw vertical banks are visible on almost every stream channel. The mountainous areas with crystaline bedrock, coarser textured soils, and more vegetative cover have the least gully and streambank erosion.

The effects of erosion are varied and far-reaching. There are interrelated physical, economic, and social consequences. A few of these effects are:

1. Loss of productive land.
2. Decrease in forage production.

PHOTO 5-4. Head cut in South Fork Dry Arroyo, Colfax County.

3. Reduction in pounds of meat and wool produced due to decrease in forage. Studies also show that crop production is reduced due to loss of topsoil. These consequences reduce the monetary value of the land.
4. Gully development decreases efficiency of operations and also causes a decline in the incentive of owners to improve land.
5. Reduction in recreation activity and wildlife harvest.
6. Sediment damages (deposition) and sediment pollution of water.
7. Gully development may intercept the water table, resulting in a lowered water table and loss of meadow hayland.

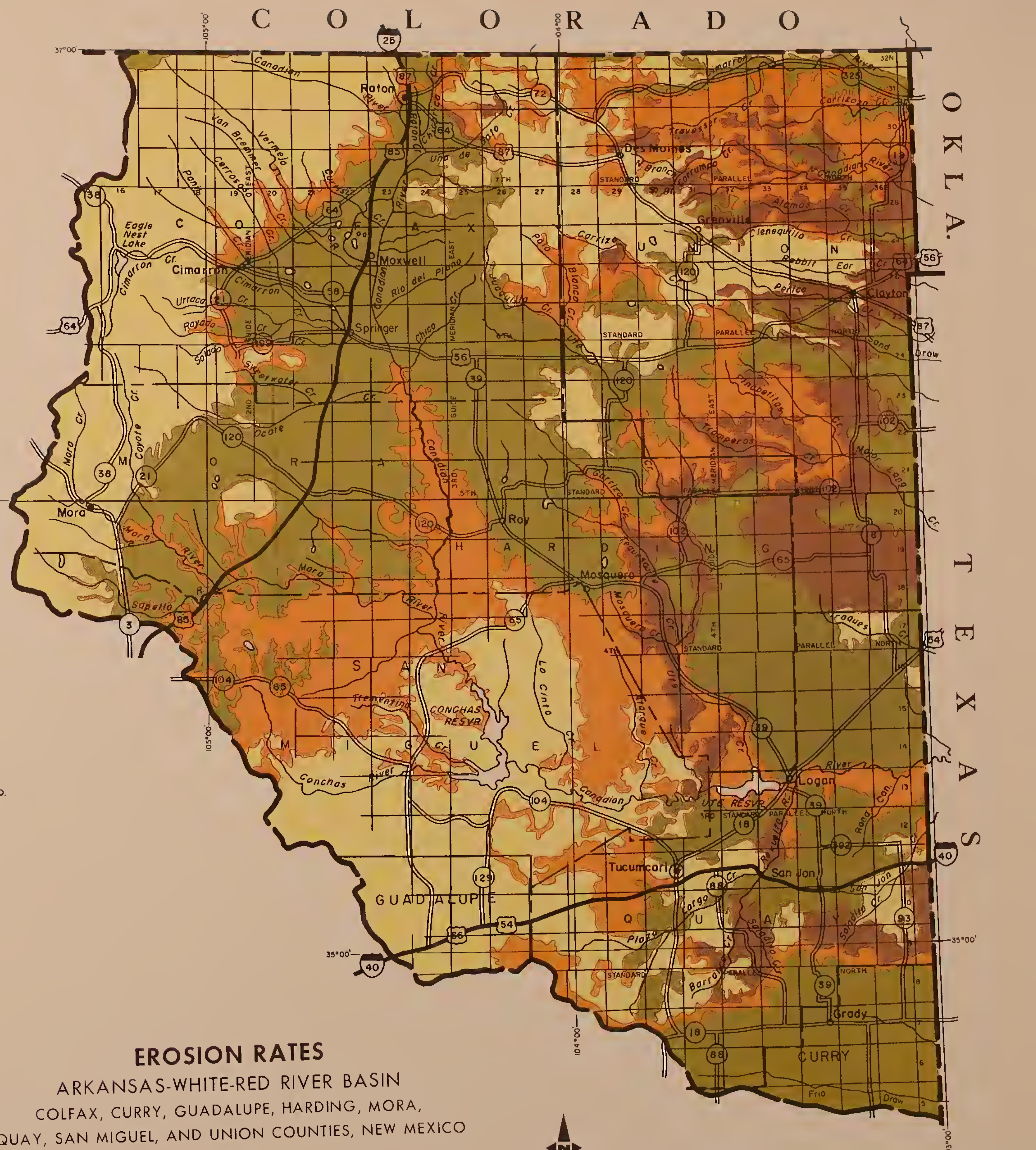
SEDIMENT

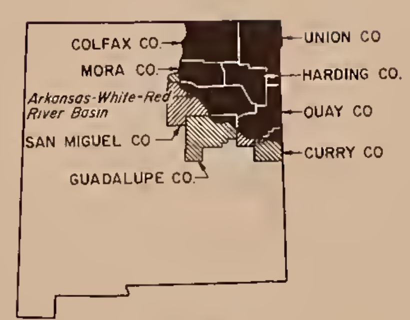
Damaging sediment is deposited on agricultural land, in irrigation canals, along streams and arroyos, and in reservoirs. Sediment deposited in highway culverts and arroyo channels increases the possibility of overbank flooding and damage. High erosion and subsequent heavy concentrations of sediment in the river waters result in an increase in salt content downriver. (Dortignac, 1956)

There are several large reservoirs which provide water for domestic, industrial, livestock, irrigation, and recreational uses. Because of relatively high sediment production in much of the basin, these lakes are filling with sediment, and valuable water is being lost due to inadequate storage.

EROSION

(orange)	1.0 - 2.0 Ac. Ft. / Sq. Mi. / Yr.
(brown)	0.5 - 1.0 Ac. Ft. / Sq. Mi. / Yr.
(light yellow)	0.2 - 0.5 Ac. Ft. / Sq. Mi. / Yr.
(olive)	Less Than 0.2 Ac. Ft. / Sq. Mi. / Yr.





LOCATION MAP

EROSION RATES

ARKANSAS-WHITE-RED RIVER BASIN
COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

Source:
Base map prepared by SCS, WTSC Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff from U.S. Department of Commerce, Environmental Science Services Administration, Weather Bureau, 1967.

U.S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1978

M7-EN-22828-22

The city of Raton has 3,800 acre-feet of storage in three reservoirs, which originally provided 4,300 acre-feet of storage. Conchas Reservoir has lost approximately 72,161 acre-feet of storage in the period 1939 to 1970. This is an average loss of about 2,373 acre-feet annually.

A sediment survey of Ute Reservoir was made December 1975. The results of the survey show the reservoir lost 19,120 acre-feet of capacity of spillway crest elevation during the period January 1962 to January 1976. This is an average loss of about 1,482 acre-feet per year.

Sediment in the water increases the turbidity and increases the cost of treatment for municipal purposes. Lake Maloya has had turbidity levels as high as 36 Jackson Turbidity Units. Permissible limits for drinking water standards are five Jackson Turbidity Units.

High concentrations of suspended sediment are damaging to fish and wildlife and associated recreation, as well as to the beauty of the river. Studies summarized in Water Quality Criteria, 1972, (Committee on Water Quality Critiera, 1972), illustrate the adverse effects of high concentrations on aquatic environments

Each county in the basin, except Curry and Guadalupe, spends an estimated average of $20,000 per year on road and bridge maintenance due to sediment deposition.

A conservative estimate of sediment damage is in the neighborhood of $366,700 annually. An estimated 7,260 acre-feet of sediment annually leaves New Mexico in the streams of the Arkansas-White-Red River Basin.

WIND EROSION

Wind erosion, primarily on cropland, is a major problem in some areas. In Curry, Harding, Quay, and Union Counties, wind erosion estimates have been made for the last nine years. In that period, Union County had an average of 17,600 acres damaged by wind annually. With improved reporting methods in the last six years, the average annual acreage has been about 24,500. During the two dry springs of 1975 and 1976, reports show wind damaged 33,700 and 53,800 acres, respectively. Harding County, with less than half the cropland of Union County, has an average of about 7,500 acres damaged annually, with a high reported in 1971 of 27,000 acres. The portions of Curry and Quay Counties in the basin have an average of 7,900 and 2,595 acres, respectively, damaged annually by wind.

Wind erosion damage ranges from slight soil movements leaving isolated plants on pedestals to complete blowout and destruction of crops and cropland. Estimates indicate the average production loss of all wind-damaged land is about 50 percent. About 14 tons per acre soil loss must occur before wind erosion damage is visibly detectable.

PHOTO 5-5. Wind erosion has exposed 24-inch concrete pipe.

LAND USE PLANNING

The public spends considerable sums of money each year for flood prevention and protection, yet flood damages increase. The lack of comprehensive and functional land use plans and zoning ordinances allows the continued development of areas that are subject to flooding.

Unplanned and unregulated expansion of existing municipalities, as well as the thousands of acres of "raw" lands that are being subdivided by transit and motor grader and then sold far afield, pose serious problems of road erosion, future higher taxes, costly utilities and services to basin taxpayers.

Some rangelands which are highly subject to wind erosion are being converted from grassland to cropland. This type of land use may have a short-time economic value but will have an adverse effect on the future economy and environmental quality of the local area.

Many of the rangelands in the basin are grazed on a continuous season-long or year-long basis. This practice has resulted in deteriorated range conditions, a decrease in forage production, and reduced income from beef production.

DRAINAGE

About 21,000 acres of irrigated land are affected by high water table and salt and/or alkali (sodium) accumulations that restrict crop growth.

The major areas affected by a high water table are along the Mora River and along the Cimarron River and tributaries. Other problem areas are isolated usually in low land along stream systems and in portions of large irrigation tracts.

There are three major causes of a high water table:

1. Sediment deposited in the river bed.
2. Seepage loss from canals and laterals. (In some instances, as high as 20 percent per mile).
3. Excessive irrigation.

A high water table that encroaches on the root zone may decrease crop production. The water table level fluctuates from season to season and is nearest the ground surface during the time of peak river flow and heaviest irrigation.

In the vicinity of the Town of Mora, the high water table creates a problem for installation and proper functioning of sewerage disposal systems. Stagnant pools of water provide breeding places for mosquitos, which may be a health hazard.

WATER DEPLETIONS AND LIMITATIONS OF SUPPLY

The average precipitation is about 16 inches (or 15,123,000 acre-feet), most of which is rainfall. Less than one percent, about 0.8 of an inch (or 756,000 acre-feet), of the yearly precipitation becomes streamflow. The remainder, about 15.2 inches (or 14,367,000 acre-feet), is used by natural vegetation, lost through evaporation, or as recharge to ground-water storage. Most of the tributary streamflow occurs in April and May each year from snowmelt. A second peak occurs in July and August from summer rains. (See Figures 3-1 through 3-4) Peak diversion requirement for irrigation occurs during June, July, and August. (See Figure 5-2)

AGRICULTURAL CROPLAND

There are three general types of water problems for agricultural uses:

1. An annual lack of sustained late season streamflow on tributaries.
2. Inefficiencies in conveyance systems and on-farm use.
3. The inability to deliver water through canal systems due to flood damages.

Inadequate streamflow occurs during the peak irrigation season in many areas. In most instances, the average annual runoff is sufficient to meet irrigation requirements if the streamflows could be regulated. However, prior water rights restrict streamflow regulation. Flows of the Canadian River fluctuate greatly, and during periods of low flows, water supplies are not adequate to meet all irrigation requirements.

Figure 5-2 is an example of unregulated streamflow and irrigation requirements on the tributaries. It shows that the streamflow exceeds the irrigation requirement in April, May, and part of June, and is less than the requirement the latter part of June and the months of July, August, and September. The shortage of water reduces by about one-third the quantity of hay that could be produced each year with a full water supply and causes a reduction in the quantity and quality of other crops that are grown.

Streamflow in late June through September is low in most years. Many of the irrigation systems are direct diversions, and when the streams are low, little or no water is available for irrigation. This is true on the Mora, Sapello, Ocate, and the Dry Cimarron drainages.

TABLE 5-2. WITHDRAWALS & DEPLETIONS - SUMMARY
1975 (in 1000 acre-feet) AWR BASIN, NM

Use	Withdrawal			Depletion		
	SW*	GW*	Total	SW*	GW*	Total
Urban	1.6	2.3	3.9	0.7	1.0	1.7
Rural	0.8	1.2	2.0	0.3	0.6	0.9
Irrigation	176.1	149.9	326.0	78.0	81.9	159.9
Manufacturing	0.0	0.1	0.1	0.0	0.1	0.1
Minerals	0.3	0.1	0.4	0.2	0.0	0.2
Livestock	2.7	2.7	5.4	2.7	2.7	5.4
Stockpond	10.3	0.0	10.3	10.3	0.0	10.3
Power	0.0	0.2	0.2	0.0	0.2	0.2
Fish and Wildlife	18.5	0.0	18.5	18.5	0.0	18.5
Recreation	0.0	0.1	0.1	0.0	0.1	0.1
Reservoir Evaporation	32.7	0.0	32.7	32.7	0.0	32.7
Total	243.0	156.6	399.6	143.4	86.6	230.0

Source: Water Use by Categories in New Mexico Counties and River Basin, and Irrigated and Dry Cropland Acreage in 1975, Technical Report 41 New Mexico State Engineer.

*SW - Surface Water
*GW - Ground Water

Water storage reservoirs have been constructed for irrigation of cropland in the Cimarron, Maxwell, Springer, Miami, and Tucumcari areas. Even though these facilities are available, years of water shortages have occurred. During the years 1954 and 1964, the supply was such that water was pumped from Conchas Reservoir below the gravity outlet works.

Surface water delivery and application systems are inefficient. Many miles of canals deliver water to on-farm application facilities and/or to storage facilities. It is estimated that at least 50 percent of the water diverted never reaches the on-farm or storage facilities.

In the Springer-Maxwell area there are several off-stream storage reservoirs. They generally have large surface area to storage ratios, which cause significant losses to evaporation. These structures were installed about 40 years ago and there is some concern that most of the original storage volume is occupied by sediment, thereby reducing storage available for irrigation water. Major storage facilities on the Vermejo Project were built in the mid 1950's.

In the Tucumcari irrigation project, approximately 33,800 acres of land were irrigated in 1975. Water is supplied from Conchas Reservoir, with a canal distribution system constructed by the Bureau of Reclamation. There appears to be about a 42 percent loss of water in the main canal system. This is significant, and leaves approximately 58 percent of the available water supply for delivery to farms. On-farm irrigation is mostly carried out with graded furrow and border methods. Little precision land shaping has been done to improve the efficiency of the surface systems.

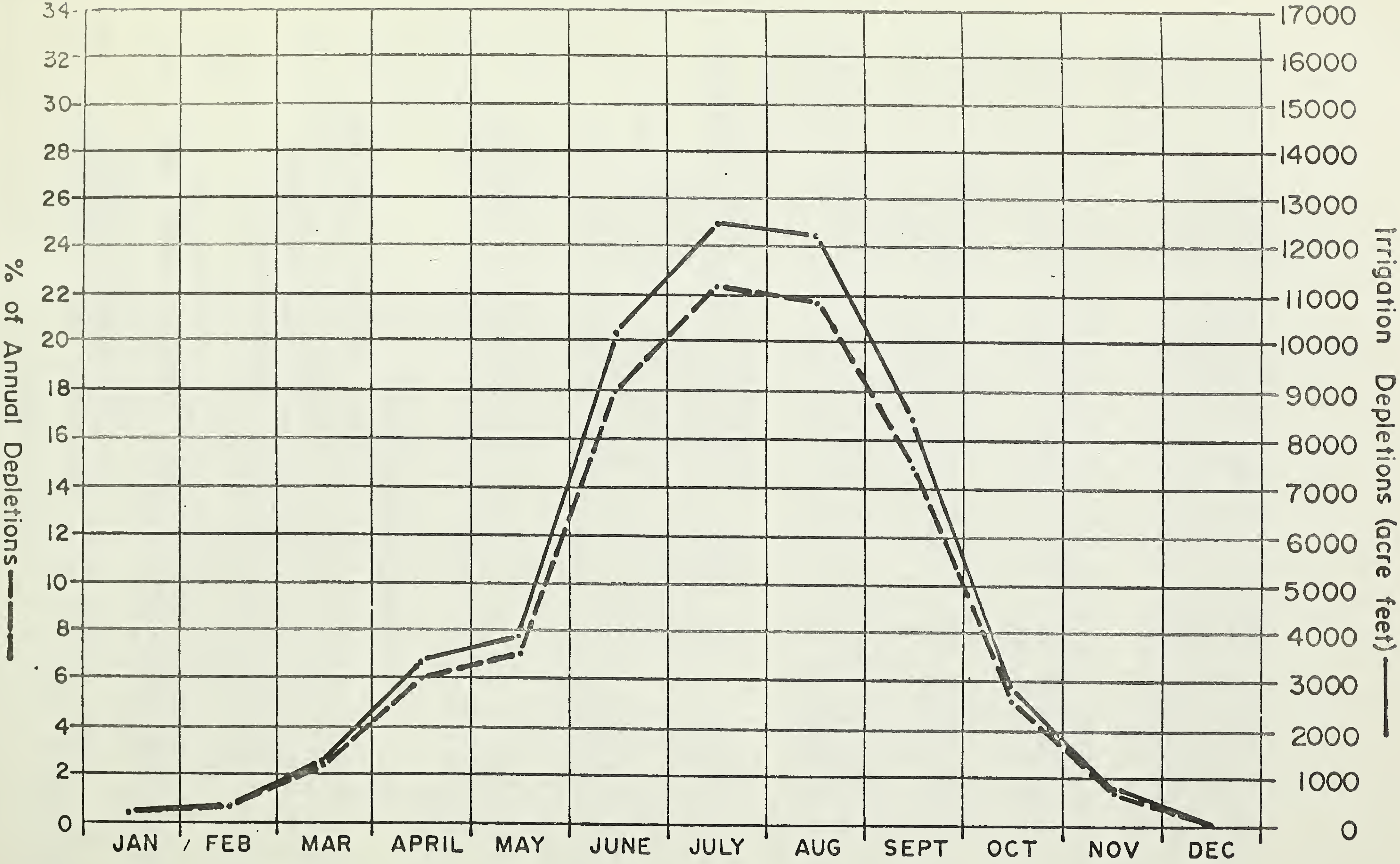
On-farm irrigation water application efficiencies are low on much of the irrigated area. The average application efficiency is estimated to be about 45 percent, and ranges from about 25 percent up to about 50 percent.

MUNICIPAL AND LIVESTOCK

The City of Raton has summer water shortages, resulting in rationing. Schedules have had to be set up for lawn watering, car washing, and any other uses considered nonessential. Community water supplies at Springer, Cimarron, and Miami may become insufficient in the near future because of population growth and/or sediment deposition depleting the storage capacity of the reservoirs.

As the requirements for municipal water increase, obtaining the water and developing the works required to assure an adequate supply will become a major problem.

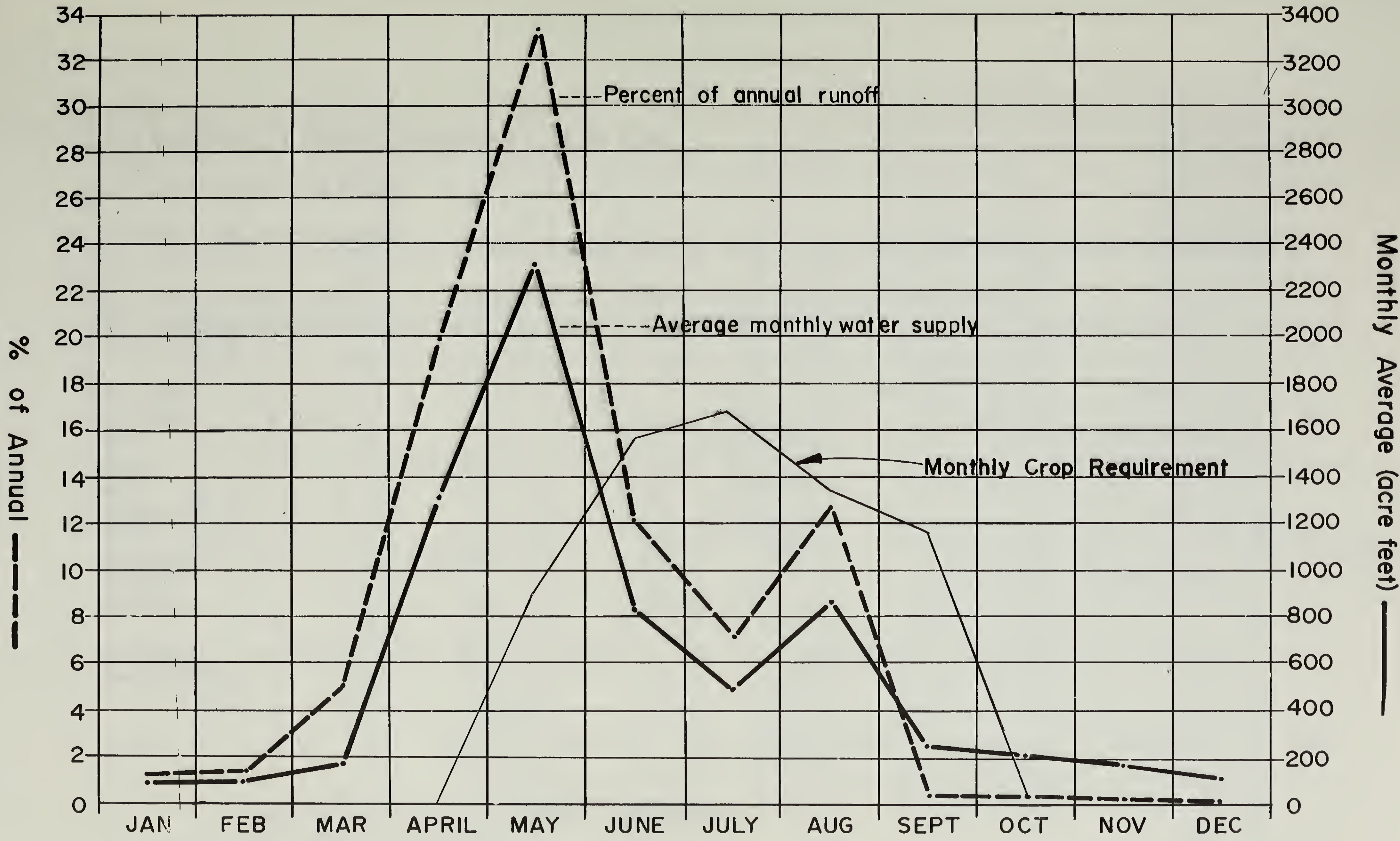
In some villages, minerals in the water are in excess of drinking water standards set by the United States Public Health Service (see Table 5-3).



Estimated Irrigation Depletions (1969)

Tucumcari Project

Fig. 5-1



Typical Monthly Distribution of Runoff
Ponil Creek near Cimarron
1951—1970

Fig. 5-2

TABLE 5-3. COMMUNITIES WITH MINERALS IN THEIR WATER SUPPLIES WHICH DO NOT MEET NEW MEXICO WATER QUALITY CRITERIA
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Community	pH	Iron	Nitrate	Fluoride	Sulfate	TDS 3/	Hardness	Other
NM State Standards	6.0-8.5	0.3 mg/l	45 mg/l	1/	250 mg/l	500 mg/l	2/	
Cimarron		0.4 mg/l		Low				
Clayton							Mod.Hard	
Des Moines		0.85 mg/l				875 mg/l		Mn. & Turb.
Grady				High				Ar.,Ni.,Se.
Maxwell				Low			Hard	Ar.
Mora				Low				
Raton		0.68 mg/l		Low			Mod.Hard	Turb. Pb
Roy				High			Mod.Hard	
San Jon	8.55 4/			V.High		1320 mg/l		Ar.,Na.
Springer				Low	258 mg/l		Hard	

1/ Fluoride content criteria varies with the average maximum daily air temperature for an area. The high or low for each community will reflect the variance from the recommended level.

2/ Softening is recommended for water exceeding 250 mg/l. The major detrimental effect of hardness is economic and inconvenience.

3/ Total dissolved solids.

4/ Average of 4 wells. Range from 8.24 to 8.74.

Inadequate distribution of livestock water causes range management problems. Poor water distribution causes over use of rangeland grasses in the vicinity of watering facilities and under utilization in other areas. This results in improper use of the range resource and loss of net income.

WILDFIRE

Wildfire will remain a constant threat as the forests accommodate more users annually. The frequency of fires fluctuates from year to year. Wildfire causes periodic losses of large volumes of timber in the basin. Based on New Mexico Forestry Division records, forest fires resulting in substantial loss, 100 acres or more, of timber and/or regeneration stands occur about every three years. In order to minimize the resource loss from fires, the following problems must be addressed:

A. Lack of early fire detection is a problem in western Colfax County. Much of this forested land is uninhabited and is not within the view of fire lookout towers. The Department of State Forestry cannot afford to make aerial reconnaissance flights as frequently as needed.

B. Poor access to fires by ground forces sometimes results in delayed initial attack and the occurrence of large fires. The use of helicopters to transport crews and/or the use of aerial fire retardants for initial attack presently are not included in the state's pre-attack budgets.

C. Inadequate slash disposal from many private timber sales has resulted in an accumulation of materials which greatly increases the probability of destructive fires. Existing forestry laws provide for slash disposal along main roads; however, the Forestry Division does not have adequate staff to enforce the law.

A 1972-73 workload analysis of the Forestry Division shows the following shortages of personnel for meeting the needs of fire management, timber management, forest products utilization, and related jobs.

TABLE 5-4. NEW MEXICO FORESTRY DIVISION STAFFING NEEDS

District	1976 Staff	1976 Needs	1983 Needs
Cimarron	2	12	14
Las Vegas	3	16	18

Source: New Mexico Forestry Division

PHOTO 5-6. Logging slash piled for disposal to reduce fire hazard.

FISH AND WILDLIFE

The effects of man's past activities and land use practices have harmed the habitats of fish and wildlife. Long periods of heavy grazing by domestic livestock have resulted in the reduction of forage plants utilized by wildlife. Increased runoff rates and the accompanying sediment yields resulting from degraded range conditions have adversely affected aquatic habitats.

Expansion of the human population and the great increase in recreational activities that have brought people into remote areas have generated conflicts and competition with the historical use of these areas by wildlife. Man-caused pollution in the forms of sediments, mining wastes, and domestic sewerage has lowered the capacity of aquatic ecosystems to support desirable fish populations.

Water-borne residues from agricultural pesticides and chemical fertilizers, industrial and commercial wastes, and irrigation can have a detrimental effect on water quality in streams and reservoirs in the area.

OUTDOOR RECREATION

There is a problem in insufficient facilities for picnicking and camping which is expressed by the overcrowded condition of many camping and picnicking areas. There are insufficient recreation parks in urban areas and natural scenic parks and recreation areas near cities. As the population increases, the pressure on existing facilities will increase.

Table 5-5 shows a comparison of outdoor recreation facilities with local demand. Projections do not show a need for additional facilities to meet local demand. However, when the demand from New Mexico out-of-basin and out-of-state is added, during peak season, the total demand exceeds the capacity of recreation facilities.

POLLUTION

Within the basin are many miles of high mountain streams containing clean water and many square miles of practically untouched land. The air at present is reasonably pure. In the lower elevations where man makes his home, pollution becomes more of a problem. Rivers contain large quantities of sediment as a result of accelerated erosion; lands have had a history of heavy grazing; some areas are denuded of vegetation due to land development; and the air of urban areas is polluted with dust and automobile fumes.

WATER

One of the principal problems of water quality is associated with sediment (New Mexico Water Quality Control Commission, 1967). Major sediment contributing areas are shown on the Erosion Rates Map. The study indicates that about 3,500 square miles have erosion rates in excess of one acre-foot per square mile per year. The sediment produced comes from sheet erosion and erosion from gullies and channels. This sediment is deposited in the streams and waterways. A high concentration of sediment detracts from the scenic beauty of streams and can be a detriment to recreation use. In some cases, the sediment-laden irrigation water causes field levels to change and reduces crop yields.

SOLID WASTE

Indiscriminate dumping and disposal of solid waste and garbage occurs near most towns and villages.

Improper disposal of solid waste and garbage degrades the natural beauty of the landscape and may also cause a health problem through pollution of water supplies.

TABLE 5-5. COMPARISON OF OUTDOOR RECREATION FACILITIES WITH LOCAL DEMAND

Type of Facility	Unit	Number	Annual Visitor Days Per Unit	Annual Visitor Days Capacity	Demand from AWR Residents					
					1975		1980		1990	
					Visitor Days	% of Capacity	Visitor Days	% of Capacity	Visitor Days	% of Capacity
Picnic Tables	each	1,044	600	626,400	72,600	12	84,100	13	106,000	17
Developed Campsites	each	312	440	137,300	32,500	24	36,800	27	47,600	35
Baseball & Softball	fields	26	10,800	208,800	138,100	66	159,000	76	201,000	96
Tennis Courts	each	21	5,000	105,000	84,100	80	95,900	91	121,500	116
Golf Course	holes	72	4,500	324,000	41,400	13	48,900	15	61,800	19
Boating & Water Skiing	Surf. Ac.	15,085	65	980,500	17,400	2	20,700	2	26,100	3
Stream Fishing	Miles	20	800	160,000	31,000	19	34,000	21	41,000	26
Lake Fishing	Surf. Ac.	14,370	100	1,437,000	50,000	3	58,000	4	76,000	5
Skiing Sites	each	3*			15,100		17,300		19,500	
Hunting Areas Waterfowl	acre	2,225*			6,000		7,200		10,100	
Upland Game	acre	40,962*			12,400		13,700		16,500	
Big Game	acre	419,200*			11,400		13,000		16,400	
Local, State & Federal Parks	acre	*			132,400		153,600		19,500	
Popular activities which require few or no facilities	Bicycling				600,000		719,600		881,100	
	Pleasure walking				478,500		560,600		706,700	
	Jogging				290,100		335,800		424,100	
	Horseback riding				115,700		133,700		168,800	
	Attending Sporting Events				107,600		127,600		158,800	

* No standards developed in New Mexico for these facilities

Sources: See references 3, 5, 6, 7, and 8 at the end of Chapter 5.

PHOTO 5-7. Proper land use regulation and solid waste control would prevent unsightly scenes such as this.

PHOTO 5-8. Burning of solid waste pollutes the air. (Tucumcari News Photo)

PHOTO 5-9. Blowing dust on State Highway 102 north of Hayden, New Mexico

AIR

Motor vehicles, industrial activity, and dust storms all contribute to the problem of air pollution in the basin.

RELATIONSHIP OF WATER PROBLEMS TO IMPAIRMENT OF NATURAL BEAUTY

Flood damage occurs in all watersheds in the basin. Damages range from minor on agricultural land to severe on developed areas. The eroded lands and deposited sediment have a detrimental effect on the environment, lowering the quality of life.

The sediment resulting from both water and wind erosion usually is deposited where it is detrimental to the total quality of life. Streams and lakes are reduced in capacity. Water conveying the materials is often not useable until after the sediment has been deposited in a reservoir. Occasionally, wind-blown sediment clogs the air, creating a health hazard, filling roads and ditches, being deposited in and around buildings, and covering fences.

BIBLIOGRAPHY

1. Committee on Water Quality Criteria, 1972, Water Quality Criteria 1972, A Report of the Committee on Water Quality Criteria, Environmental Studies Board, National Academy of Sciences, and the National Academy of Engineering at the request of the Environmental Protection Agency, Washington, D. C.

2. Dortignac, E. J. and W. C. Hickey, Jr., 1963, Surface Runoff and Erosion as Affected by Soil Ripping in Proceedings of the Federal Interagency Sedimentation Conference, 1963, Miscellaneous Publication No. 970, Agricultural Research Service, U. S. Department of Agriculture.

3. Gray, Jane R. and Thomas J. Blair, 1971, Characteristics of Recreationist in Northeastern New Mexico, New Mexico State University, Agriculture Experiment Station Research Report 209.

4. New Mexico Water Quality Control Commission, 1967. Water Quality Standards.

5. Soil Conservation Service, District Conservationists, Official Correspondence and Communications During Report Development.

6. State Planning Office, 1973, Out-of-State Visitor Recreation Demand Patterns in New Mexico.

7. State Planning Office, 1975, Recreation Resource in New Mexico.

8. University of New Mexico, 1975 Participation in Outdoor Recreation, A Survey of New Mexico Residents, Bureau of Business and Economic Research, Institute for Applied Research Services, the University of New Mexico.

CHAPTER 6

PRESENT AND FUTURE NEEDS

FOR WATER

AND RELATED RESOURCE DEVELOPMENTS

This chapter addresses the social, economic and resource needs to meet the water and related land resource problems discussed in Chapter 5. The needs are based on input from the agriculture sector of the basin, the State Engineer Office and the Division of State Forestry.

CHAPTER 6. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED RESOURCE DEVELOPMENTS

E C O N O M I C   A N D   S O C I A L

The basin is predominantly agricultural, with small rural communities. Throughout the area there is evidence of a declining rural and farm population, with agricultural technology and economics increasingly forcing people off marginal, small farms. Abandoned farms and ranches, ghost towns, and dying towns clearly illustrate this. The climate of the basin will not support large, intensely farmed areas. Irrigation is required to produce crops with any certainty, and frequently irrigation water is in short supply. Without the introduction of more water from outside the basin, agriculture will continue to be a range cattle operation. This requires large efficient units to remain solvent.

PHOTO 6-1. Trementina, abandoned farming community in east central San Miguel County.

PHOTO 6-2. Abandoned farmstead north of Newkirk, New Mexico in the AWR River Basin.

Certain areas in the basin, mainly in Mora and San Miguel Counties, contain small farms and ranches. These are not economic units, and the owners must depend on other employment, welfare, or both to remain on the land. Land title clearance aggravates this situation. A title clearance program for Mora and San Miguel Counties might help to alleviate this situation.

As people from rural areas migrate to larger towns, many unskilled workers end up on welfare and intermittent employment. This places a greater burden on state welfare resources. Training is needed to develop the skills of these people.

There is a need for more doctors and improved medical services within the basin. Medical facilities in the basin are limited. Most small communities have no doctor, and distances required to travel for medical services can exceed 75 miles. Tucumcari, Clayton, and Raton have hospitals which provide medical services within the basin. Las Vegas, just outside the basin, has hospital facilities which serve much of the southwest portion of the basin. Clovis and Taos also have hospitals which serve some parts of the basin.

Clinics provide limited medical services in Mora, Cimarron, and Springer. Scattered ambulance and fire department rescue units make up the remainder of medically associated services.

GENERAL AGRICULTURAL NEEDS

Some general agricultural needs suggested to alleviate problems are:

1. There is a need to improve irrigation delivery and application efficiencies on about 120,000 acres of irrigated cropland.

2. There is a need to increase irrigation water supplies during summer months. There are irrigation water shortages on about 116,000 acres of irrigated cropland.

3. There is a need to reduce excessive erosion on about 2.2 million acres of rangeland.

4. There is a need to reduce excessive erosion on about 80,000 acres of dry cropland.

5. There is a need for adequate conservation treatment to maintain the resource base on 4 million acres of agricultural and forest land.

CROPLAND RESOURCES

Irrigated Land

Nearly 6.4 million acres of land in the basin are suited for irrigation. Of this, approximately one million acres are Class 1/ I, 2.6 million acres are Class II, 1.5 million acres are Class III, and 1.3 million acres are Class IV. Class I is the best suited and Class IV is the least desirable for irrigated crops. Soil characteristics, such as texture, moisture holding capacity, salinity or alkalinity, permeability, and topography, were used to place soils in various classes. 2/ The land was placed in irrigable classes without regard to the availability of irrigation water, land location, size, shape, or pattern of suitable areas.

Although there are 155,780 acres of land developed for irrigation, only about 124,250 acres are presently irrigated. This is nearly all that can be irrigated from present water supply except for the addition of acreage in the eastern part of the basin using ground water sources.

The major crops are corn, sorghum, wheat, alfalfa, and seeded pasture. Other crops include vegetables, dry beans, and orchards. In addition to these planted crops, about 10,000 acres of native pasture are irrigated.

1/ Classes are defined in Chapter 3.
2/ New Mexico State University, Agricultural Experiment Station, Research Report 239, 162, 165, 205, 202, and 221, (soil association and land classification for irrigation).

Most soils presently irrigated in the basin have few limitations. However, localized areas have one or more limitations which restrict their use somewhat. These limitations include poor drainage, salinity or alkalinity, low available water holding capacity, shallow root depth, rapid or slow permeability, and erosion hazard.

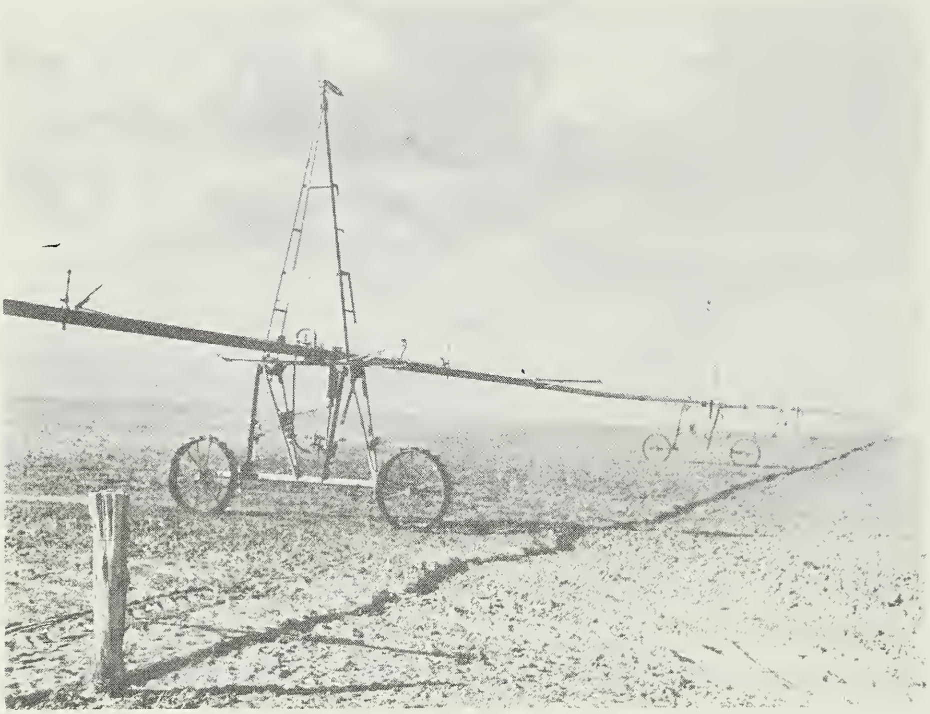


PHOTO 6-3. Center pivot sprinkler irrigation systems are popular where ground water is used. The highest irrigation efficiencies obtained in the AWR are in groundwater areas using sprinkler systems.

TABLE 6-1 LAND SUITABLE FOR IRRIGATION IN THE ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Land Class

County	Class I	Class II	Class III	Class IV	Total
	acres				
Colfax	64,800	519,700	235,770	266,040	1,086,310
Curry	83,340	28,110	27,150	7,230	145,830
Harding	160,390	353,370	258,730	146,030	918,520
Mora	82,740	263,650	76,230	185,970	608,590
Quay	155,960	464,850	396,910	66,450	1,084,170
San Miguel	131,870	331,890	235,630	341,450	1,040,840
Union	320,390	632,030	238,390	333,530	1,524,340
Total	999,490	2,593,600	1,468,810	1,346,700	6,408,600

Source: See Footnote 2

Areas where poor drainage is a limiting factor are in mountain valleys that are devoted to native pasture and in areas where slowly permeable clay soils are irrigated. Large areas of the Vermejo Project experience poor drainage which limits crop production. Most of these areas can be improved with subsurface drainage. Production can be improved by management and planting improved forage species.

Soils adversely affected by salinity and alkalinity are limited in extent and are scattered throughout the basin. These areas are generally caused by inadequate drainage and seepage from irrigation canals.

The soils having low available water holding capacity consist of shallow soils and very sandy soils. The former occur in some mountain valleys and the latter along the eastern edge of the basin.

Soils along the valley side slopes are subject to erosion when seeded to annual crops. Most areas of sloping soils are used for perennial grasses for grazing or legumes for hay, and erosion is not a serious hazard. In addition to soils having water erosion hazard, some sandy soils in the eastern part of the area have severe wind erosion hazards.

PHOTO 6-4. North arm of Conchas Reservoir. Note the low water and mud flats. This photo was taken in the spring of 1977 when lakes should have been nearly full.

Irrigation water is from streams or wells. Frequently there is inadequate flow in the streams for full season irrigation. Even sizeable water storage facilities such as Conchas Reservoir do not provide adequate irrigation water during some years. The irrigated area around Maxwell and Springer is frequently short of irrigation water.

Another problem on much of the irrigated land in the basin is noxious weeds which compete with crops for water. The most widespread noxious weed is field bindweed. Many fields in the Maxwell-Springer area are heavily infested with this plant. Some fields throughout the rest of the basin are also affected.

Nonirrigated Cropland

The major areas of nonirrigated cropland are in Harding, Union, southern Quay, and northern Curry counties. Scattered tracts also occur throughout the basin.

Nonirrigated crops have been in the area since the middle 1880's. Corn, wheat, oats, and forage crops were the major crops planted by early farmers. However, cropping has changed to wheat and grain sorghum, crops more suited to the climatic conditions.

Both seasonal and annual precipitation are erratic. In addition, an apparent multi-year cycle of above and below average rainfall is indicated by recorded data. During years when rainfall is above average, farmers have generally increased acreages of cropland. However, during years of below normal rainfall, crop yields are too low for economic return. During these periods croplands have been abandoned or planted to permanent vegetation. The major limiting factor to continued dryland crop production is moisture shortage.

Most nonirrigated soils used for cropland are deep, nearly level, or gently sloping, medium to moderately coarse textured and well drained. Except for climate, these soils have only minor limitations for crop production. However, they have moderate to severe wind erosion hazards and are damaged by soil blowing when not protected by cover. Some soils in the eastern part of the area have sandy textured surfaces and are subject to damage because of very severe wind erosion. These soils are generally better suited to permanent vegetative cover.

POTENTIAL VEGETATION

CONIFEROUS FOREST FORMATION

- Engelmann Spruce Series
- Douglas Fir-White Fir-Spruce Series
- Douglas Fir-Ponderasa Pine Series
- Panderasa Pine-Oak Series
- Panderasa Pine-Rocky Mauntain Juniper Series

MOUNTAIN GRASSLAND FORMATION

- Thurber Fescue-Arizona Fescue-Tufted Hairgrass Series

CONIFEROUS WOODLAND FORMATION

- Pinyon-Juniper Series

BROADLEAF WOODLAND FORMATION

- Oak Woodland Series

PLAINS GRASSLAND FORMATION

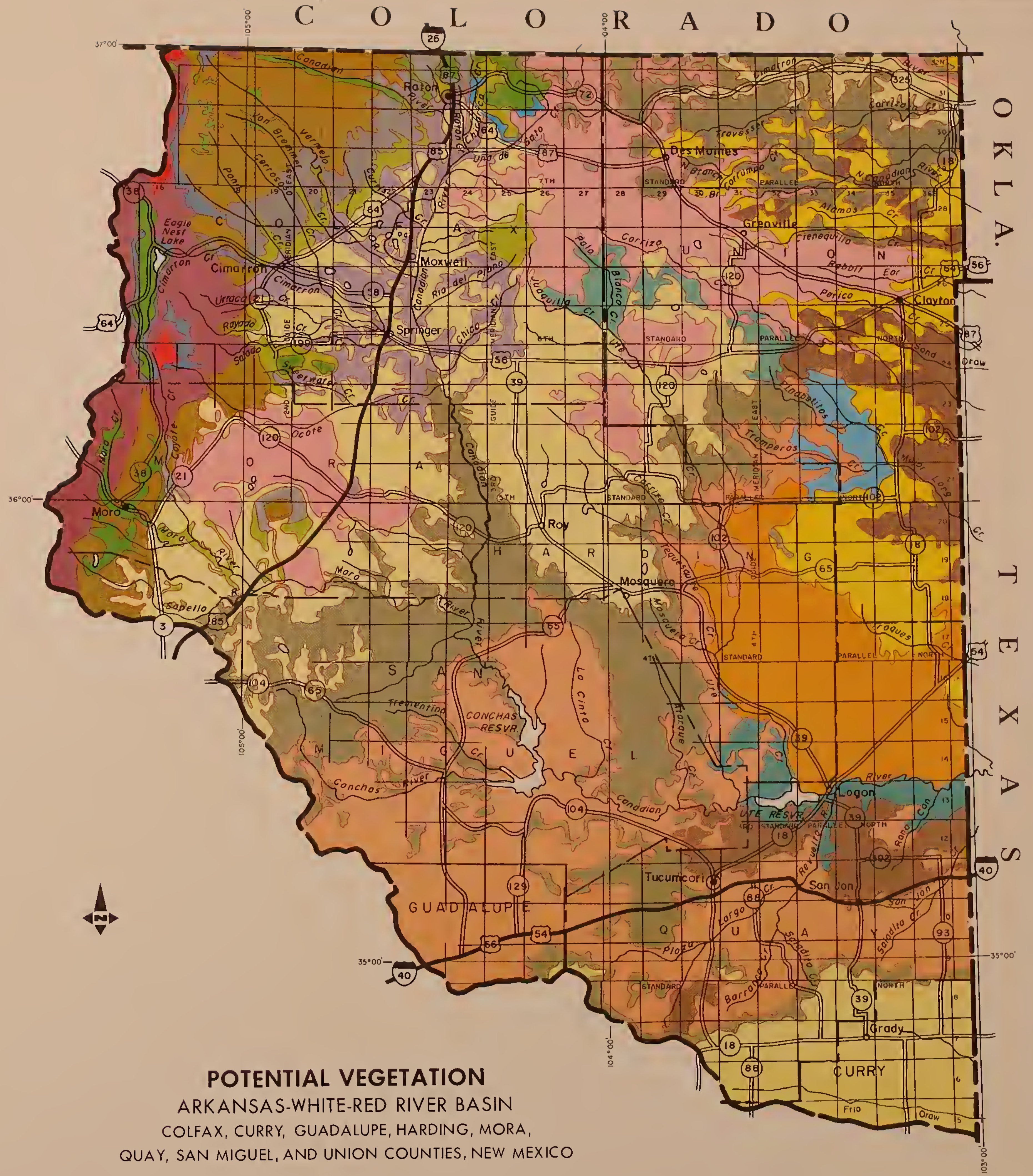
1. Blue Gramo Series
   - A. Blue Gramo-Western Wheatgrass Associotion
   - B. Blue Grama-Buffalagrass Association
   - C. Blue Grama-Galleta Association
2. Mixed Grama Series (Blue Grama nat dominant)
   - E. Sideoats-Little Bluestem Associatian
   - F. Sideoats Grama-Little Bluestem-Blue Grama Associatian
   - G. Little Bluestem-Sideoats Grama Association
   - H. Juniper-Little Bluestem-Sideoats Grama Associatian

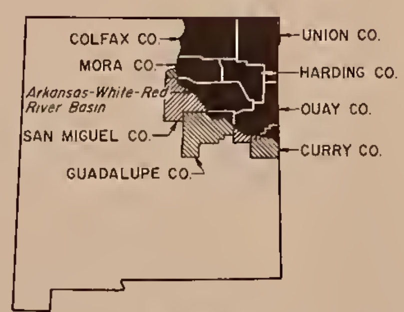
- Sacaton-Faurwing Series

PRAIRIE FORMATION

- Sondsage-Bluestem Series

- BODIES OF WATER





LOCATION MAP

POTENTIAL VEGETATION
ARKANSAS-WHITE-RED RIVER BASIN
COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-2

PHOTO 6-5. Soil blown from cropland in Arkansas-White-Red River Basin.

Rangeland

There is excessive erosion on about 2.2 million acres of rangeland. Continuous use of the grazing resource in the AWR River Basin has caused a steady decline in range conditions and lowered productivity.

The range management requirements necessary to correct the situation will require conservation measures and, in some cases, long rest periods. The cool-season grass species will require time to reestablish. Management which will increase cool-season species will in turn restore the vigor and high productivity of the warm-season plants. On depleted ranges which have good soil productivity and adequate precipitation, reseeding can be used to reestablish grasses.

The economic factors involved are the high cost of restoring these lands to their potential and relatively low returns over the years required to restore the vegetation. Water development, fencing, mechanical treatment, and the implementation of grazing systems will mean relatively high fixed cost. These costs are high even when amortized over the expected life of the resource management system and the low returns tend to discourage some ranchers from investing in resource development and improvement.

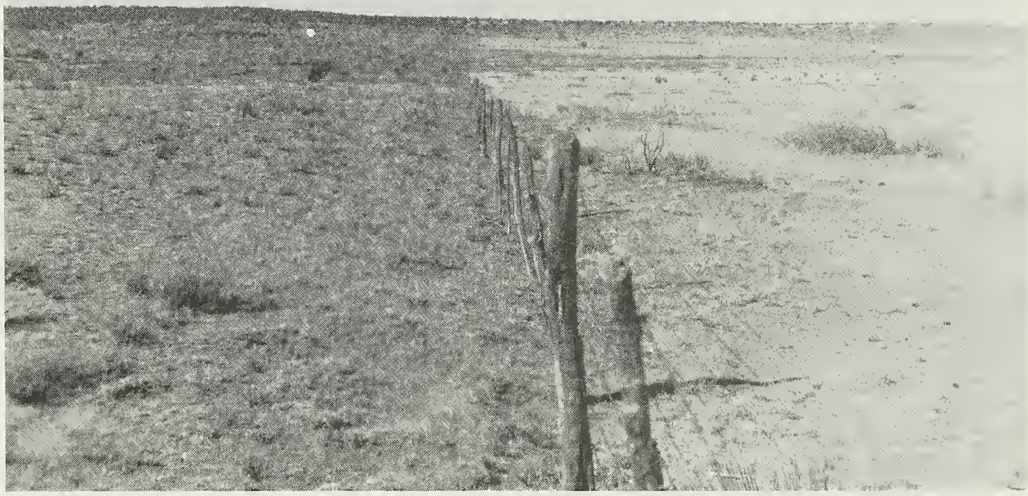


PHOTO 6-6. Spring, 1977. Rangeland on left is badly managed and needs improved management to realize potential productivity. San Miguel County, NM.

Resource management systems which will increase productivity at a minimum cost need to be developed. Native vegetation can be improved by applying resource management systems which allow it to reach its potential, increasing forage production and protecting the range resource for future productivity.

The requirement for red meat will increase with the population. However, increasing livestock numbers without increased forage production and reduced supplemental feeding will increase the economic cost to the livestock industry and adversely affect wildlife and recreational use of the grassland. Efficient use of the resource by careful balance of livestock, wildlife, and forage resource is essential for economic survival.

Livestock

In 1969, it was estimated that 301,429,000 pounds (live weight) of beef and veal were produced in the basin. According to OBERS projections, in 1980, 2000, 2020, the basin share of the national demand for beef and veal will be 207,986,000, 227,315,000, and 301,820,000 pounds, respectively.

Forest land

The anticipated demand of timber lands for other uses and the expected increase in the demand for wood products indicate a need for an accurate forest inventory to determine volume, stand condition, age class distribution, and productivity. The 1976 and 1977 inventory of state and private forested lands will provide a portion of this information.

Ninety-five percent of the forested land is in state and private ownership. The majority of these lands are not being managed for wood or wood fiber production. In most instances, the primary uses and revenue received from timber lands are livestock grazing, trespass fee hunting, and outdoor recreation. Increased funding for the Forestry Division is needed to meet the demands of forestry technical assistance on state and private forest lands.

Approximately 90 percent of the forested land has been logged one or more times. Fires, insects, and disease destroy timber periodically; consequently, an estimated 100,000 acres need planting or seeding. Also, there are an unknown number of acres which need thinning to release the better trees in overstocked and stagnant tree stands. Plans for better management practices need to be developed and implemented on the ground, as a means for minimizing sediment and other water pollutants resulting from road construction, logging, and other forestry activities.

PHOTO 6-7. Stand of ponderosa pine thinned to improve timber production.

Improved harvesting practices are needed to maximize wood utilization and minimize soil disturbance and impacts on wildlife habitats. Sawmill improvement programs are needed to reduce residual wastes.

WATERSHED PROTECTION AND MANAGEMENT

Land treatment measures and programs for the protection and management of watershed areas and the preservation of the resource base are needed throughout the basin. Principal management needs of watershed lands are grazing systems, deferred rotation grazing practices, proper logging practices, proper road construction, and erosion control measures. In conjunction with the above-mentioned practices,

PHOTO 6-8. Gullies caused by runoff from poorly managed rangeland Colfax County, AWR River Basin. Spring, 1977.

many areas are in need of measures such as brush control and revegetation to establish ground cover. Conservation measures such as gully plugs, debris basins, etc., are needed to reduce gully and stream bank erosion and subsequent sediment damage. Table 6-2 shows the estimated land treatment needs in the basin.

TABLE 6-2 ESTIMATED LAND TREATMENT NEEDS IN THE ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

LAND TREATMENT SYSTEMS NEEDED	ACRES NEEDING TREATMENT
Nonirrigated Cropland	
Residue and annual cover	58,900
Sod in rotation	1,900
Contouring only	70,100
Stripcropping terracing diversions	59,400
Permanent cover	52,500
Irrigated Cropland	
Drainage	11,700
Cultural management practices	13,200
Improved irrigation systems	105,000
Water management	105,000
Openland and Formerly Cropped	
Permanent cover	11,200
Pasture	
Pasture management	9,200
Range	
Range proper use	4,036,600
Reestablishment	677,500
Commercial Forest Land	
Forest and timber management	1,026,400
Grazable Woodland	
Proper grazing use	2,553,400
Other Land	
Erosion control and protection	16,200

Source: New Mexico Conservation Needs Inventory, 1970

FLOOD PREVENTION

The current (1975) analysis of watersheds in the basin indicated there are no remaining projects where structural measures can economically be justified to reduce flooding damage under the Small Watershed Program, Public Law 566.

Floodplain studies would be useful to assist in planning residential and commercial expansion and should include depth and frequency of flooding along stream channels and in pond areas.

FLOOD INSURANCE

Several communities have flood problems for which structural flood protection measures cannot economically be justified. However, the National Flood Insurance Act of 1968, as amended, and the Flood Disaster Protection Act of 1973 were enacted to inform communities about their flood danger, provide new construction and reasonable protection from flood damage by prudent management of the floodplain, and protect residents of flood-prone areas against financial loss from flooding. Within the basin, 13 communities and all 8 counties have been identified as flood-prone. Seven of the communities and two counties are participating in the National Flood Insurance Program. Additional communities and counties may apply for participation by showing that certain minimal floodplain management measures are in effect and express the intent to adopt additional specified measures.

In New Mexico, the coordinator of the National Flood Insurance Program is the State Engineer. Those governing bodies wishing information about flood insurance should contact the State Engineer.

LAND USE PLANNING AND ZONING

The need for land use planning and zoning is evident when flood prevention and protection costs are related to the public funds spent annually for emergencies. Historically, as public investment in flood protection increases, so does the expenditure for flood caused emergencies.

There is a need for counties to develop comprehensive land use planning and zoning ordinances which consider the soil, water table, drainage characteristics, slope of the land, subsurface geology, and flood hazard. As areas of land are being changed from agricultural to residential and commercial uses, studies are needed to determine the economic and social impacts and the suitability of the land for the intended land use change.

LAND STABILIZATION

There are 2.2 million acres of rangeland that are eroding excessively. Some measures mentioned under watershed protection and management are applicable and needed in stabilizing critically eroding areas. Improved range management is needed. Inventories of soil and present vegetation conditions are essential to the planning of grazing systems and proper range use. Each ranch operator must have a working knowledge of the native forage plants, how vegetation grows and reacts to grazing, seasons of growth, forage value, and productivity. Also, knowledge of the behavior of important species and range trends, and plant propagation habits are essential to proper management. The development of range conservation plans to improve range conditions through resting, planned

grazing systems, brush management, and mechanical treatment of the rangeland are the responsibility of the owner and/or operator. A rancher should understand the changes in vegetation and know how to handle it in accordance with the changing needs. Range improvement will come only when the ranchers understand and practice management of the vegetation.

PHOTO 6-9. Gullied and eroding rangeland along Dry Cimarron River caused by increased runoff due to overgrazing. Spring, 1977.

The resource base on about 4 million acres of agricultural and forest land is not being maintained due to inadequate conservation treatment. The requirements for agricultural and forest products will increase with the population. However, the increasing agricultural and timber production without conserving and protecting the resource base will increase the cost to the industries and adversely affect wildlife, recreation, and water quality.

DRAINAGE IMPROVEMENT

Drainage is not a major problem within the basin. Some mountain valleys in Mora, Colfax, and San Miguel Counties could be drained to improve forage production. The effects on wildlife habitats would need to be investigated.

Some areas around irrigated projects have developed high water tables, wet areas, and saline or alkaline soils. Drainage, combined with better irrigation water management, is needed. Drainage improvement cost elements are shown on Table 6-3.

TABLE 6-3 SUMMARY OF IRRIGATION AND DRAINAGE NEEDS AND COSTS

ARKANSAS-WHITE-RED RIVER BASIN - SUBBASINS	PROBLEM IRRIGATION AREA (ACRES) 1/	IRRIGATION DEVELOPMENT COST ESTIMATES 2/ (DOLLARS)	AREA NEEDING DRAINAGE (ACRES)	DRAINAGE COST ESTIMATES 3/ (DOLLARS)	PROJECT COST ESTIMATES (DOLLARS)
Dry Cimarron (1R 4/)	4,200	840,000	0	0	840,000
Canadian (1V)	22,700	4,540,000	5,700	257,000	4,797,000
Cimarron Creek (1V1)	25,000	5,000,000	0	0	5,000,000
Mora River (1V2)	20,300	4,060,000	1,000	45,000	4,105,000
Conchas River (1V3)	0	0	0	0	0
Ute Creek (1V4)	0	0	0	0	0
Tucumcari Creek (1V5)	25,000	4,250,000	5,000	200,000	4,450,000
Carrizo Creek (1V6A)	1,800	360,000	0	0	360,000
Major Longs Creek (1V6B)	4,300	860,000	0	0	860,000
North Canadian (1V9)	1,300	260,000	0	0	260,000
	104,600	$20,170,000	11,700	$502,000	$20,672,000

1/ Area from 1969 New Mexico Conservation Needs Inventory.
2/ Unit cost composite of $200 per acre except Tucumcari Creek, $170 per acre.
3/ Unit cost composite of $45 per acre except Tucumcari Creek, $40 per acre.
4/ CNI Report Watershed numbers.

WATER NEEDS

Table 6-4 shows water available for depletions. The projections indicate little increase in surface water availability and nearly tripling the availability of ground water.

TABLE 6-4 WATER AVAILABLE FOR DEPLETION 1/

	1970	1980	2000	2020
Water Available				
Surface	202,000	202,000	202,000	202,000
Ground	63,000	110,000	135,000	165,000
Total	265,000	312,000	337,000	367,000
Projected Requirement	265,000	334,400 2/	363,500 2/	448,500 2/
Need 3/	0	22,400	26,500	81,500

Source: SEO and U. S. Bureau of Reclamation, Water Resources Assessment, 1976.

1/ Expressed as acre-feet per year of depletions
2/ Figures based on 1972 state population projections.
3/ Water may be available at remote locations near the New Mexico-Texas state line:
   (a) Dry Cimarron River and tributaries - 6,000 acre-feet.
   (b) Canadian River and tributaries below Ute Dam - 31,000 acre-feet. This quantity may not be useable due to limitations imposed by the Canadian River Compact.

Projected requirements show a deficit in the period beginning in the 1970's and increasing throughout the projected periods. These figures do not reflect water salvage or water savings due to increased efficiency of irrigation.

This water could be developed for livestock water, high value uses that can meet development costs, or possibly irrigation water in remote areas near the Texas-New Mexico state line. The water is not readily available to areas showing deficiencies.

Efficient use of rangeland requires adequate livestock watering facilities. Installation of stock water ponds, wells, and pipelines for water distribution is needed to fulfill this requirement. Present water depletions related to livestock are about 14,400 acre-feet per year, which includes 12,600 acre-feet of surface water and 1,800 acre-feet of ground water. Assuming the proposed rangeland treatment program is applied, livestock numbers and water use should decrease. Improved distribution system of some stock water should reduce water use.

IRRIGATION

By 1969, irrigated lands were developed to the extent of the water supply available, except in some ground water areas. A major part of the irrigated land utilized surface water. Irrigation water delivery efficiencies ranged from about 25 to 60 percent, and farm efficiencies from 25 to 65 percent. The higher efficiencies are on ground water irrigated areas in Union County, and reflect the efficiency of the entire system. The delivery efficiency is the estimated amount delivered to the farm against the amount diverted from the source.

The on-farm efficiency is estimated by dividing the consumptive use requirement of the plant by the available water delivered to the farm.

Lined canals and farm ditches would increase delivery system efficiencies and on-farm water availability. Water available at the farm could be more than doubled in many areas.

Designing and implementing irrigation systems to incorporate the best equipment and techniques for individual farms could have the effect of greatly increasing available water for consumptive use.

Lack of water during drier parts of the growing season reduces crop yields. In some areas, water is plentiful during snow melt runoff but lacking later in the season. Additional storage is needed to store excess runoff for later, drier periods. Current New Mexico water law and the economic situation restrict the alternative of additional irrigation storage. Construction of storage is contingent upon the acquisition and transfer of water rights. The economic return of irrigated crops in some areas of the basin will limit the introduction of improved equipment, systems, and management.

PHOTO 6-10. Lined irrigation canals and ditches may increase water available to the crop as much as 100 percent or more.

COMMUNITY WATER SUPPLIES

There are 46 community water supplies in the basin. Most of the water is obtained from groundwater, and only four systems are supplied by surface water. Most systems seem to be adequate for present and future needs, with Raton in Colfax County being the exception. Raton's supply is not adequate to meet present demands during drought conditions. With an increasing population and an agreement to supply water to the National Rifle Association facilities southwest of the city, Raton needs to locate and develop larger water supplies to meet projected future needs. The Bureau of Reclamation has suggested several sources to the city of Raton in a recent study report. 1/

Water quality of several municipal water systems is below recommended standards for some elements according to the U. S. Health Service recommendations. The communities are using the only water available, and will, in the future, be required by federal regulation to provide treatment to meet minimum standards for municipal water supplies.

1/ Information on Raton Water Supply Studies, November, 1976, Dept. of Interior, Bureau of Reclamation, Southwest Region, Amarillo Texas.

FIRE MANAGEMENT

Increased emphasis on fire prevention is needed to reduce the number of man-caused fires. County-wide fire prevention planning needs to be completed for all counties. There is a need for improved detection of forest and range fires. Old lookout towers need to be replaced or relocated. Aerial detection needs to be increased following lightning storms.

Rural fire fighting units need additional training and equipment. The rural community fire protection program needs to be continued in order to upgrade the ability of state and local fire forces in the protection of life, property, and natural resources.

The state forestry needs increased funding to enforce fire prevention laws and laws which require slash disposal on timber sales. There is a need to implement the effective use of fire as a management tool and to identify those areas where the accumulation of fuels could be reduced by prescribed fires.

FISH AND WILDLIFE HABITAT MANAGEMENT

Fish and wildlife resources in the basin should be given adequate consideration in the formulation of all related resource planning. There will be continuing and expanding pressure to preserve and enhance those remaining habitats needed to supply the demands for hunting and fishing.

Additional big game habitat needs to be improved, primarily through the coordination of range and timber management planning. Because of the limited amounts of fishing water in the basin it will be desirable to create permanent waters in all proposed impoundments. Many miles of existing streams are in need of fish habitat improvement to allow for the full utilization of their fish production potential.

Lakes and ponds need remedial management to control aquatic weeds and rough fish species. Streambank stabilization and erosion control are needed in some streams that are tributaries to lakes in order to reduce the sediment load reaching the lakes. Phreatophyte areas are useful for wildlife habitat and add to recreation resources. About a third of the phreatophyte area would provide some of the needs for recreation. However, it is pointed out that the expansion of phreatophyte areas would reduce the water supply now being used for other purposes.

OUTDOOR RECREATION

The most sought after recreational experiences are those that have a special attraction, such as streams, lakes, climatic relief, scenery, and open space. Overcrowded conditions necessitate a need to study and improvise methods to disperse users. Other needs include prevention of erosion and site deterioration resulting from heavy use. There is a need to analyze and improve existing facilities that limit use, resulting from inadequate parking, signing, access, etc. It is necessary to determine the carrying capacity of the resource in relation to the capabilities of the land base to withstand the impact. Roads need to be improved to provide access to the desirable recreation sites that are now inaccessible.

With 85 percent of the basin lands in private ownership, the private recreation sector is recognized as fulfilling a significant portion of the total spectrum of recreation supply. There are large tracts of private forest land which are well suited for both developed and undeveloped outdoor recreation. In recent years, large tracts of privately owned land have been developed for recreation purposes, such as Pendaries and Angel Fire. Some private lands are presently being utilized for fee hunting, fishing, and camping.

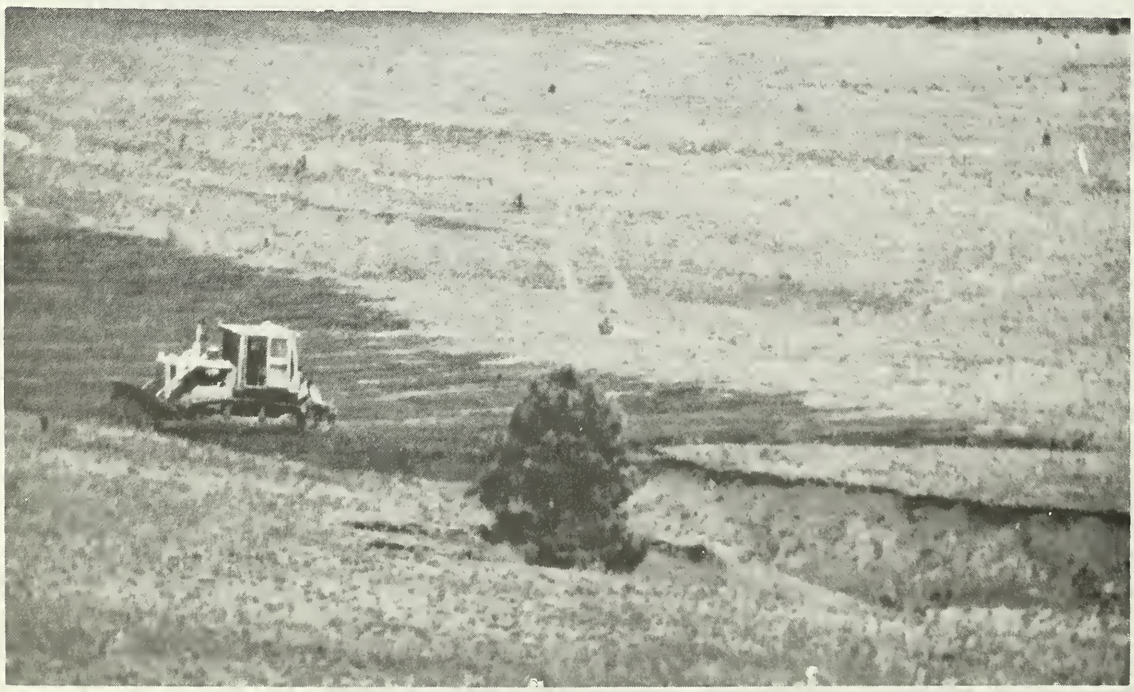


PHOTO 6-11. Gully reclamation prior to developing recreation home sites in the mountain areas of the basin. Gully is shaped and seeded to stop erosion.

POLLUTION

Conservation land treatment is needed to reduce erosion and consequent pollution of air, streams, and lakes by sediment. The reduction of erosion also reduces the movement of agricultural chemicals and reduces salt loading of surface water.

Solid waste disposal sites need to be operated as sanitary land fills and indiscriminate dumping of trash and waste should be stopped.

PHOTO 6-12. Indiscriminate dumping of trash and waste is a problem in the basin.

A number of point source pollution sites are listed in the Arkansas River Basin Plan, June 1975, published by the New Mexico Water Quality Control Commission (page V-VII-V-IX and Table 16). This list indicates action being taken, planned or needed.

POWER SUPPLY

The following table depicts power usage in the basin, both historic and future demand. Although the numbers do not reflect absolute power usage in the basin, they do indicate the relative magnitude of increase over time. (The data indicates historic use has increased at an increasing rate.) Future use was projected to increase at a constant rate.

TABLE 6-5 ESTIMATED ELECTRIC POWER REQUIREMENTS
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

YEAR	Power Requirements	Average Annual Increase for the Period
	kwh x 10^6	
1960 1/	60	--
1970 1/	128	6.8
1980 2/	240	11.2
2000 2/	390	7.5
2020 2/	540	7.5
		8.0 Avg.

1/ Estimates provided by rural electric cooperatives.
2/ Projected by River Basin field party using trend line analysis.

CHAPTER 7

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

This chapter discusses existing projects and programs designed to solve some of the water and related land problems in the basin. Within the U. S. Department of Agriculture programs of the Soil Conservation Service, Agricultural Stabilization and Conservation Service, Farmers Home Administration, Economics, Statistics and Cooperatives Service, Science and Education Administration and Forest Service are discussed. A brief background is given for each, along with some of their contributions in the basin.

Programs of the U. S. Army Corps of Engineers, the Bureau of Reclamation, Bureau of Land Management, Fish and Wildlife Service, National Park Service and the Geological Survey are covered. State of New Mexico programs are also discussed.

CHAPTER 7. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Conservation Operation

Public Law 46 was passed by the Seventy-fourth Congress in 1935. The Act formally recognized soil erosion as a "menace to national welfare" and declared it "as the policy of Congress to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, and prevent impairment of reservoirs...." The Soil Conservation Service (SCS) provides technical assistance to farmers, ranchers, and other landowners or users in planning, applying, and maintaining soil and water conservation under Public Law 46.

Most of the conservation work accomplished with SCS technical assistance is carried out through local Soil and Water Conservation Districts. In 1975, there were approximately 1,668 district cooperators within the seven conservation districts which are located entirely in the basin and with the four districts partially within the basin. Conservation district agreements and conservation plans cover approximately 8,540,000 acres of agricultural land, or about 78 percent of the land in the basin eligible for conservation agreements.

Related activities of SCS include soil surveys and interpretations, propagation of new conservation plant material, and technical assistance in several disciplines with other USDA programs.

Resource Conservation and Development Projects

Under the Food and Agriculture Act of 1962, (Public Law 87-702) the United States Department of Agriculture, with the Soil Conservation Service providing leadership, provides technical and financial assistance to local groups in resource conservation and development projects (RC&D). These projects are locally initiated, sponsored, and directed. They provide local groups the opportunity to coordinate and use federal, state, and local programs and assistance. The goals of RC&D are to develop, improve, conserve, and use the natural resources for sustained production, for the enhancement of the environment, and to improve the standard of living of the residents in the community or project area.

There are two resource conservation and development projects in the basin. They are the Adelante RC&D Project, which includes Colfax, Mora, and San Miguel Counties, and the El Llano Estacado RC&D Project, which includes all of Union, Harding, Quay, Guadalupe, and Curry Counties. 1/

1/ Counties or portions of counties in the AWR.

Great Plains Conservation Program

The Great Plains Conservation Program (Public Law 84-1021) was authorized in 1956. It was amended in 1969 to extend the program through 1981. This program provides cost-sharing of approved practices which are agreed upon in a soil and water conservation plan. The conservation plan is developed by the land user, with assistance from the SCS through the conservation district, for a three to ten-year period. The plan is a legal contract that assures the application and maintenance of permanent conservation measures to protect the natural resources of the farm or ranch unit.

In 1975, there were 191 contracts under the Great Plains Conservation Program in the basin. These contracts cover about 1,478,335 acres of agricultural land. Contracts that have expired or been terminated covered an additional 3 million acres.

Small Watershed Program

The Watershed Protection and Flood Prevention Act (PL-566) was passed in 1954, and is known as the Small Watershed Program. The Act authorizes the Secretary of Agriculture to cooperate with local sponsors, including soil and water conservation districts, counties, towns, and special purpose districts, in the planning and installation of land treatment for watershed protection and structural measures for flood prevention, irrigation, drainage, recreation, fish and wildlife, and municipal and industrial water supply.

Under the Act, the sponsoring local governments can plan, construct, operate, and maintain watershed projects. PL-566 projects are federally assisted projects rather than federal projects. The Soil Conservation Service, acting on behalf of the Secretary of Agriculture, provides both technical and financial assistance to local sponsors.

The PL-566 Act provides for a project type approach to soil and water resource development and use. It requires active participation and initiative from local sponsors in the watershed. The program encourages the close cooperation of state agencies and emphasizes the partnership of local, state, and federal agencies in carrying out the watershed program.

Six watersheds in the study area have been approved for planning under PL-566, of which the Tramperos Creek and Saltpeter Creek Watersheds have been completed. The Tucumcari Draw Watershed project was terminated in 1976 because it was found to be not economically feasible. Planning was suspended on the three Dry Cimarron Watersheds in 1961 due to failure in the organization of a watershed district. Preliminary investigations have been made on Chico Rico Creek, Upper Mora River, and Carrizozo Creek (Union County) Watersheds. The sponsors have withdrawn their application for assistance on Upper Mora River and Carrizozo Creek (Union County) Watersheds. A preliminary report on Chico Rico Creek Watershed did not demonstrate economic feasibility.

The sponsoring organizations of Carrizozo Creek, Cienquilla Creek, Corrumpa Creek, Garita Creek, Monia Creek, Perico Creek, and Vermejo River Watersheds have withdrawn their applications for planning assistance.

Floodplain Management Assistance Program

Local communities or units of government are eligible for SCS assistance for flood hazard studies carried out under Section 6 of Public Law 83-566, and reimbursable flood insurance studies performed for the Department of Housing and Urban Development, Federal Insurance Administration.

The objectives of the program are to collect and furnish information on flood hazards and floodplains and to provide interpretations of flood hazard data needed by state and local governments in developing, revising and implementing their floodplain management programs.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

The Agricultual Stabilization and Conservation Service (ASCS) programs are designed to stabilize the nation's agricultural economy, conserve farm resources, and protect food and feed reserves.

Agricultural Conservation Program

The Agricultural Conservation Program (ACP) provides cost sharing of fifty to seventy-five percent on the carrying out of approved forestry and conservation practices. Practices applicable in the study area under the 1976 ACP include establishment of permanent vegetative cover, water impoundment reservoirs, diversions, stream bank stabilization, sediment retention structures, and erosion control structures. Practices are designed to provide long-term protection to soil and water resources. In addition, state and county committees are given the opportunity to develop other practices needed to solve local conservation problems.

Long-Term Agreements

Under long-term agreements (LTA), essential practices and practice cost-sharing are scheduled over a period of three years and are based on whole farm conservation plans which have been approved by the county committee.

Land users may participate individually, or two or more participate in pooling agreements, on projects that will provide common benefits to their land or to the overall community. For example, a number of farmers in a watershed may combine practices or measures to reduce erosion, thereby benefiting recreation development, reservoirs, or other water impoundments.

FARMERS HOME ADMINISTRATION

The Farmers Home Administration (FmHA) provides another source of supervised credit which supplements the efforts of private lenders. Most FmHA programs require that a borrower obtain commercial credit when he is able to do so. The nature of the agency's operation makes it possible for the Farmers Home Administration to increase the supply of rural credit by drawing money from the major finance centers of the nation.

Most of the loan programs are either guaranteed or insured. Guaranteed loans are those in which the loan is made and serviced by a private lender. FmHA guarantees to limit any loss to a specified percentage. Interest rates are determined between borrower and lender unless the rate is established by law.

Insured loans are made and serviced by the personnel of the agency. Notes are sold to investors and the investors' money replenishes a revolving loan fund. Most program interest rates to borrowers are determined by the current cost of federal borrowing, although some rates are established by law.

FOREST SERVICE

The Forest Service is responsible for federal leadership in forestry, including the management, protection and utilization of the natural resources on forests and related rangelands. It carries out this role through the following activities: (1) Protection and management of 209,608 acres of National Forest and National Grasslands within the AWR Basin as described in Chapter 9; (2) Cooperation with New Mexico Forestry Division and the State Department of Agriculture for the management, protection and utilization of 1,167,000 acres of nonfederal commercial forest land; (3) research in various aspects of forestry; and (4) participation with other agencies in manpower, youth and community assistance programs seeking to improve living conditions in rural areas.

Cooperative Forestry Assistance Act of 1978

This act provides cooperative forestry assistance to States for application on nonfederal forest lands. Provisions of the Act include:

Section 3 - Rural Forestry Assistance. Financial and technical assistance is available to the states. They in turn provide technical information and advice to private forest landowners, forest operators and wood processors regarding:

- harvesting, processing and marketing forest products.

- management planning and treatment of forest land for increased quantity and quality of timber and other forest resources.

- forest soil fertility and water yields.

- fish and wildlife habitat.

Section 4 - Forest Incentives. This program is to encourage landowners to apply practices for afforestation of suitable lands, timber stand improvement, and forest resources management and protection so as to provide for the production of timber and other forest resources. Landowners are eligible for cost sharing funds under this program if they own one thousand acres or less of private forest land.

Section 5 - Insect and Disease Control. The Forest Service provides leadership in prevention, detection, evaluation and suppression of forest insect and disease outbreaks on all forest lands. In New Mexico, the State Department of Agriculture is the state cooperating agency.

Section 6 - Urban Forestry Assistance. Financial and technical assistance is available to the states. They in turn provide information and assistance to units of local government for urban forestry programs. The objective is to create a more attractive, healthful, enjoyable and productive environment for people to live, work and play.

Section 7 - Rural Fire Prevention and Control. The Forest Service cooperates with state foresters in developing systems and methods for prevention, control, suppresion and prescribed use of fires on rural lands and in rural communities. The states organize, train and equip local fire fighting forces. Excess federal property and equipment are available for state and local fire fighting forces.

Section 8 - Management Assistance, Planning Assistance and Technology Implementation. The Forest Service provides the state forester advice and information for organizational management, forest resource planning and application of new research findings.

Agricultural Conservation Program (ACP) provides for up to 75 percent cost sharing for the establishment of trees or shrubs for soil protection, forestry purposes or environmental improvement and to improve woodlands on private lands.

The Forest Service participates with other USDA agencies in the following cooperative programs: Small Watershed Protection (PL-566) and Flood Prevention (PL-534), River Basin Surveys, and Resource Conservation and Development.

ECONOMICS, STATISTICS AND COOPERATIVES SERVICE

The Economics, Statistics and Cooperatives Service (ESCS) analyzes factors affecting farm production and their relationship to the environment, prices and income, and the outlook for various commodities. It studies production efficiency; marketing costs and potentials, rural development and natural resources; agricultural trade, production, and Government policies. ESCS makes their findings available to the public through bulletins and the Extension Service and helps other USDA agencies analyze and plan.

SCIENCE AND EDUCATION ADMINISTRATION

The Science and Educaton Administration (SEA) performs research in crop and livestock production, soil and water, and related areas. Both ESCS and SEA can provide information and analyses on a contract basis for basin problems.

RURAL ELECTRIFICATION ADMINISTRATION

The Rural Electrification Administration (REA) has a significant impact upon both farm and rural non-farm residents and their ability to utilize water and related land resources more efficiently. Service is being provided to customers throughout the area upon request and as the need arises. The REA provides loan resources for the Southwest Electric Cooperative, Springer Electric Cooperative, Mora-San Miguel Electric Cooperative, and the Farmers Electric Cooperative. The cooperatives serve most of the area in the AWR basin.

U. S. DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

The Corps of Engineers provides flood control assistance to communities under three authorities: individual project authorization by Congress, projects approved by the Chief of Engineers, and emergency and disaster assistance under Public Laws 84-99 and 93-288.

The Chief of Engineers has authority for snagging and clearing in stream channels, small flood control projects, and emergency bank protection for public works and nonprofit organizations.

In addition, the Corps is authorized, (under Section 206 of the 1960 Flood Control Act), to provide assistance to communities in the identification and use of floodplains.

Conchas Dam and Reservoir

The Conchas Dam was constructed by the Corps of Engineers as a flood control facility with capacity allocated to irrigation water storage for the Tucumcari project.

The reservoir and dam are operated and maintained by the Corps. The reservoir is also used for recreation, fish, and wildlife. Recreation facilities have been installed at the site.

U. S. DEPARTMENT OF INTERIOR

BUREAU OF RECLAMATION

Tucumcari Project

The irrigation project was completed in 1950 and lands developed for irrigation amounted to approximately 38,000 acres. The project works of the Tucumcari irrigation project consist of the 55 mile-long Conchas Canal which takes water from the Conchas Reservoir to the irrigated lands, a distribution system and the drainage system.

The Tucumcari irrigation project is operated and maintained by the Arch Hurley Conservancy District in accordance with agreements between the district and the Bureau of Reclamation. Water assessments are paid by individual landowners to the conservancy district.

Vermejo Project

The Vermejo Project was authorized in 1950 for the purpose of rehabilitation and improvement of the existing irrigation works of the Maxwell Irrigation District. The rehabilitation and improvement work included construction of a concrete diversion dam on the Vermejo River with a canal to three off-channel storage reservoirs. Flood detention storage capacity is provided in the Stubblefield Arroyo Reservoir (Lake 7 and 8) in addition to irrigation water storage. This lake also provides a fishery. The system supplies irrigation water to about 7,200 acres of cropland in the project area. The district has diversion rights from Chico Rico Creek.

The Vermejo Project is operated and maintained by the Vermejo Conservancy District in accordance with agreements between the district and the Bureau of Reclamation. Water assessments are paid by landwoners to the conservancy district.

FISH AND WILDLIFE SERVICE

The Fish and Wildlife Service cooperates with other federal and state agencies to develop the full value of the basin's fish and wildlife. Their fish hatcheries supply some of the stock for public and state fishing waters within the basin.

Predatory animal and rodent control is conducted under a cooperative program to protect livestock, game, crops, forage, and irrigation structures. It also curtails incidents of wild-animal-borne disease to which humans or valuable animals may be susceptible. Under cooperative agreement with New Mexico Game and Fish Department federal agents also enforce state as well as federal game laws.

Maxwell National Wildlife Refuge

This refuge is located in Colfax County and covers approximately 3,100 acres, of which 400 acres are administered by the Fish and Wildlife Service and 500 acres are privately owned. Small game found in the area include cottontail, ducks, geese, quail, and pheasant.

NATIONAL PARK SERVICE

Significant segments of prehistoric, historic, and scenic areas are preserved under the National Park System for enjoyment and inspiration of the people. Capulin Mountain National Monument in Union County is a 775-acre area containing a volcanic cinder cone 1,000 feet high. Fort Union National Monument, established in 1956, contains 721 acres in Mora County. It was the largest U. S. military post on the southwestern frontier. The National Park Service also renders assistance on historic, archeological, historical and natural landmarks with federal, state, and Indian programs.

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management (BLM) has jurisdiction over mineral, range, recreation, forest, wildlife, and water resources on 0.63 percent of the land (acres) in the basin. Most of the land is primarily suited to wildlife and livestock grazing, and a little is forest.

Grazing privileges are granted by licenses and permits, which specify numbers, classes, and season of use. Range improvement projects such as brush control, erosion control structures, stock tanks, and fences are involved in range use administration. Effects on wildlife habitat are also considered in range development. Recreational development programs are under way in cooperation with the State Park Commission.

BLM is charged with making examinations to determine the mineral character of the land, validity of mining claims, land suitability leading to classification, appraisal of mineral materials, and land classified for title transfer. They also handle the mineral leasing for oil and gas, potassium, phosphate, coal, sodium, and sulphur.

The BLM receives all applications for use of the national land reserve and its resources. It maintains all basic land records from early territorial days. It has custody of Spanish land grant records from early 1600, on which most of the land title of New Mexico is based. They perform official cadastral surveys to determine property boundaries.

GEOLOGICAL SURVEY

The U. S. Geological Survey (USGS) cooperates with local, state, federal agencies, and private organizations in conducting stream-gaging programs to determine water quantity and quality. The USGS operates 32 gage

stations in the basin which include five reservoirs or lakes and four canals or ditches. Data are gathered on water quality at 12 stations in the basin. Chemical data are collected at all stations; biological data at three stations; and sediment data at four stations. In addition, the USGS cooperates in studies of underground water supplies and detailed topographic mapping. USGS in cooperation with the New Mexico State Engineer performs ground water studies to obtain water level and quality data. Ground water levels are published for Colfax, Union, Quay and Curry Counties.

STATE OF NEW MEXICO

SOIL AND WATER CONSERVATION DISTRICTS

Soil and Water Conservation Districts (SWCD's) are entities of state government, organized by local referendum under provisions of state law. They are directed by local boards of supervisors, elected by owners of land lying within the district boundaries. The districts provide local direction in resource planning, development, and utilization of land and water resources. Districts provide a means for individual land users and organized groups to participate in the planning and installation of soil and water conservation measures needed to protect and improve water and related land resources for sustained production.

The district programs are carried out with technical assistance from the Soil Conservation Service under a memorandum of understanding. Other federal and state agencies assist the district in soil and water conservation activities.

Soil and water conservation districts have limited taxing authority, up to one mill, subject to approval by referendum vote by landowners in the district. Financing is generally met by limited appropriations of county and state governments and through the support of individual land users. Districts serve as co-sponsors for Public Law 566 watershed projects, as well as resource conservation and development project measures (Public Law 87-702).

All of the study area is in soil and water conservation districts. Districts completely within the study area are Colfax, Northeastern, Ute Creek, Mesa, Mora-Wagon Mound, Western Mora, and Canadian River. Located partly in the study area are Tierra y Montes, Guadalupe, Southwest Quay, and Central Curry Districts.

STATE ENGINEER GRANTS-IN-AID DITCHES PROGRAM

The Legislature of the State of New Mexico appropriates to the State Engineer monies from the New Mexico irrigation works construction fund for grants-in-aid to ditches stating that the funds are to be used "For the purpose of constructing, improving, repairing, and protecting from floods the dams, reservoirs, ditches, flumes, and their appurtenances located or planned within the counties of this state." Authorized repairs

also include repairs for flood damage. The Act further states, "Not more than fifteen percent of the total cost of any one project shall be paid out of this appropriation, and under no circumstances shall more than ten thousand dollars ($10,000) of the amount appropriated be spent on the works of any one community ditch."

The State Engineer is authorized to enter into cooperative agreements with the owners or commissioners of dams, reservoirs, ditches, flumes, and appurtenances in counties of this state to insure that the work will be done in the most efficient and economical manner, and may contract with the federal government or any of its agencies or instrumentalities, which provide matching funds or assistance in carrying out the purpose of this act. The State Engineer may not grant funds to private individuals or corporations.

Usually state financial assistance for acequia work performed by ditch commissions is shared with financial assistance from the Agricultural Conservation Program (ACP). The cost of engineering and inspection of the ACP program is performed by the Soil Conservation Service at no cost to the State or to the ditch commission.

NEW MEXICO IRRIGATION WORKS CONSTRUCTION FUND

The New Mexico Interstate Streams Commission has funds available for loans to qualified organizations for rehabilitation of irrigation works. Loans are made for a period of up to 10 years at an interest rate of 2 1/2 percent.

ANTELOPE VALLEY IRRIGATION DISTRICT

The Antelope Valley Irrigation District is a political subdivision of the State of New Mexico organized under the laws of the state. The District owns, operates and maintains works of improvement to distribute irrigation water to the members of the District.

DEPARTMENT OF GAME & FISH & PARK AND RECREATION DIVISION

These are the principal state agencies that develop and maintain facilities for recreation, fish and wildlife purposes. The state manages 45,387 acres of recreation land in the basin of which 2,060 acres are developed, 42,417 are undeveloped and 910 acres are water.

The State, through appropriate agencies, will assume the major leadership responsibility in coordinating the efforts of all levels of government in providing outdoor recreation opportunities. 1/

1/ New Mexico SCORP, (State Comprehensive Outdoor Recreation Plan), 1976.

A 1973 State Outdoor Recreation Act created the State Supplemental Fund to assist small communities (15,000 or less population) with 25 percent of the total cost of a federally funded project through the Land and Water Conservation Fund Program. 1/

Agencies involved in recreation planning efforts are:
State - State Planning Office, State Park and Recreation Division, Game and Fish Department, and Highway Department.

Federal - Bureau of Outdoor Recreation, Forest Service, National Park Service, Fish and Wildlife Service, Bureau of Land Management, Bureau of Reclamation, Soil Conservation Service, and Corps of Engineers.

Ute Dam and Reservoir

The New Mexico Interstate Stream Commission constructed Ute Dam which was completed in 1963. The project was designed to utilize water alloted to New Mexico. Fish, wildlife, and recreation are the only purposes or uses of Ute Reservoir at the present time. However, there is presently a proposal to supply water to the Eastern New Mexico Water Supply Project.

Recreation facilities adjacent to the reservoir have been installed by the Park and Recreation Division and have been designated as Ute State Park. The Game and Fish Department maintains the warm water fishery at Ute Reservoir.

Clayton Lake

The Game and Fish Department constructed Clayton Lake for recreation, fish, and wildlife. The dam for the lake was completed in 1956. Recreation facilities have been installed by the Park and Recreation Division at the lake and are designated as a state park. A fishery is maintained by the Game and Fish Department and approximately 400 acres around the lake are managed for waterfowl.

Several other natural and man-made lakes in the study area have been developed and managed for fish, wildlife, and/or recreation by the Department of Game and Fish. They include Wagon Mound Salt Lake, Charette Lake, La Cueva Waterfowl Refuge, Morphy Lake, Elliot S. Barker Wildlife Area, Colin B. Neblett Wildlife Area (Cimarron Canyon), and Chicosa Lake.

ENVIRONMENTAL IMPROVEMENT DIVISION

The Environmental Improvement Division (EID) was organized in 1971 as the division within the Department of Health and Environment responsible for water and land environmental programs such as domestic water supplies, water quality, vector control, and solid waste management. Regional offices administer the agencies programs with the aid of a professional environmentalist assigned to each county.

1/ New Mexico SCORP, (State Comprehensive Outdoor Recreation Plan), 1976.

The goal of the EID is "to insure an environment that: (1) in the greatest possible measure, will confer optimum health, safety, comfort, and economic and social well-being on its inhabitants; (2) will protect this generation, as well as those yet unborn, from health threats posed by the environment; (3) and will maximize the economic and cultural benefits of a healthy people."

FORESTRY DIVISION

This department was created by the Forest Conservation Act of 1957. The responsibilities of State Forestry are to provide the following services to the people of New Mexico.

1. Technical advice and assistance in forest management planning to forest landowners, forest product operators and community planners.

2. Forest fire prevention, detection and suppression.

3. Distribution of tree planting stock.

4. Cooperation with the Agricultural Stabilization and Conservation Committees (ASCS) in the forestry phases of the Agricultural Conservation Program (ACP).

Specific details of State Forestry programs are described in this chapter under Forest Service.

PUBLIC ASSISTANCE PROGRAMS

Public welfare programs aid in training welfare recipients. Two federal programs designed to combat "hard core" unemployment are the Area Redevelopment Act (ARA) and the Manpower Development and Training Act (MDTA). Both give the New Mexico Employment Service the responsibility of identifying occupational training needs and the selection of trainees. The choice of training sites and the actual training are functions of the State Department of Education.

FOUR CORNERS ECONOMIC DEVELOPMENT REGION

The Four Corners Economic Development Region is a state-federal partnership set up in 1966 to promote economic development in 92 counties of Utah, Arizona, Colorado, and New Mexico. Some of the purposes of the commission are to initiate and coordinate overall economic development programs, perform faster surveys and studies, promote increased private and public investment in the area, assist in state and federal planning, and advise and assist the Secretary of Commerce in the initiation and coordination of economic development districts. All counties of the basin are within the New Mexico portion of the Commission boundaries.

AREA PLANNING ORGANIZATIONS

Within each State Planning and Development District in New Mexico is an area planning organization which functions as the regional association of local governments in the district. Some are called Councils of Government and others are referred to as Economic Development Districts. All have similar functions. Each serves as a clearinghouse under federal authority of the Office of Management and Budget - Circular A-95. Most proposed projects involving federal expenditures are reviewed by the clearinghouse for consistency with on-going programs. Other functions involve regional, area-wide, and local planning efforts designed to support local decisions and to provide a framework for development activities.

PRIVATE PROJECTS

Private irrigation systems include the Miami Project, Springer Ditch Company Reservoir, Charles Springer Cattle Company, Rito Del Plano, La Cueva and Red Lake, and the Throttle Reservoir. The Miami, Eagle Nest Lake, and Springer reservoirs also provide for fishing, in addition to irrigation water storage.

Other private lakes in the study area developed for recreation include Adams Lake, Bartlett Lake, Mary Lake, Lake David, and Lake Isabel.

CHAPTER 8

WATER AND RELATED LAND

RESOURCE DEVELOPMENT POTENTIAL

This chapter describes some of the potential water and land resource developments in the area relative to satisfying the problems and needs described in Chapters IV, V, and VI. Some of the possibilities expressed here are not presently economically feasible or socially desirable. However, as future social and economic changes occur, these possibilities may become a reality.

CHAPTER 8. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

FLOOD PROTECTION

WATERSHED PROJECTS

An evaluation of 26 upstream watershed projects was made in the basin. See Chapter 5, Flood Damage. Economic analysis indicates the watersheds are not feasible at this time under existing PL-566 or RC&D criteria and evaluation procedures.

FLOOD INSURANCE

The Flood Disaster Protection Act of 1973 makes it possible for individuals within the communities of Cimarron, Logan, Raton, San Jon, Springer, Clayton, and Tucumcari to obtain flood insurance. In addition, persons living in unincorporated areas of Colfax and Mora Counties are qualified to purchase flood insurance. All counties identified as flood prone and all identified flood-prone communities were required to enter the Flood Insurance program by July 1, 1975 (or one year after identification, whichever is later), or no loans from federally-insured or regulated bank or savings and loan associations will thereafter be available for buildings within these identified special hazard areas. An ordinance regulating land use in flood-hazard areas is a prerequisite for insurance. Legislative action has been taken to authorize local governments to adopt the necessary ordinance.

LAND USE PLANNING AND ZONING

Cities and counties are authorized by the state legislature to establish zoning regulations. The entire basin is in need of comprehensive land use planning. Floodplains should be clearly identified on maps. Standards for residential and commercial development of floodplains should be drawn up. There are many areas that can be developed for residential and commercial uses and would be relatively free of problems relating to soils, drainage, high water table, and flooding.

Flood hazard and flood insurance studies outline areas of flooding potential. This program should be actively pursued in the basin to give local planners flood hazard information for land use planning and zoning. The Soil Conservation Service, Corps of Engineers and Flood Insurance Administration can provide this assistance to communities.

Soil surveys, published by the Soil Conservation Service in cooperation with the New Mexico Agricultural Experiment Station, are an excellent source of information. Soil surveys analyze the soil resource for its potential to support building sites, sanitary land fills, septic systems, and other uses. The surveys give limitations for each soil in a number of alternative uses.

L A N D T R E A T M E N T

Land treatment systems have the greatest potential for development of the basin's water and related land resources. Agricultural production can be increased, erosion and sediment decreased, and social well being enhanced.

RANGELAND TREATMENT

Rangeland treatment systems have the potential to increase forage production and decrease erosion on about 9,425,000 acres. The potential increase in forage production can bring about an increase in grazing capacity for about 720,000 AUM's by 2020. Soil erosion could be decreased by 8,880 acre-feet per year.

Rangeland treatment systems include management practices and capital improvements. Generally, management practices, such as planned grazing systems, are low cost, while capital improvements are high cost and might include fencing, range seeding, brush management and water development. Management practices and capital improvements are not separable. In various combinations, they make up a rangeland treatment system tailored to the needs of the resource and the ranch operator. The systems are costly, both from the standpoint of out-of-pocket expense and lost revenue, when the treatment system is initiated. Ranchers can fund the capital improvements with the current cost-share programs; however, some ranchers may find it difficult to absorb the lost revenue for the two to four years required for defered grazing on the rangeland. Future cost share arrangements might include compensation for lost revenue. The increased land treatment costs to develop the rangeland to its maximum potential by 2020 are about $9.8 million, while revenues are estimated to increase to $13.4 million.

CROPLAND TREATMENT

About 291,310 acres of cropland have the potential to respond to land treatment systems. Of this, about 124,250 acres are irrigated land and about 167,060 acres are dryland. Application of needed land treatment will increase production, increase irrigation efficiencies, decrease erosion, and decrease soil nutrient losses. The following discussion presents data for irrigated and dry cropland.

Abandoned Cropland Management

Abandoned cropland management is applicable to previously cultivated lands that are not well revegetated or that are vegetated with plants of negligible value. The management objective is to reduce erosion, increase infiltration, reduce sediment yields, and increase forage production. Much of this land is not suited for cultivated cropland. The best use is rangeland. Seeding to adapted grasses is needed to meet the objectives. Management after seeding should be conducive to maintaining a vigorous stand of grass.

PHOTO 8-1. Livestock water developments help livestock distribution and provide better utilization of available forage.

PHOTO 8-2. Fenceline contrast. Rangeland treatment systems increase forage for livestock, provide better wildlife habitat, and decrease erosion and sediment.

PHOTO 8-3. Gully and streambank erosion. Rangeland treatment systems will increase plant cover and reduce runoff, erosion and sediment.

<u>Irrigated Cropland Management</u>

Irrigated land management applies to all land that is developed for, and is presently, irrigated. The minimum management objectives are to maintain or improve the soil, prevent erosion, and increase irrigation efficiency. The soil can be maintained or improved by use of high residue producing crops and a suitable cropping system. Erosion can be controlled by measures such as proper irrigation and land leveling, in addition to a suitable cropping system and residue management. Irrigation efficiency can be increased by improving the irrigation system, lining canals and field ditches, and irrigation water management on the field.

Improved varieties, timely tillage, planting, and harvesting; good weed, insect, and disease control; and a good fertility program are needed for maximum production.

Maximum production can be obtained on pasture and hayland by applying the above measures plus rotation grazing and timely harvesting of hay.

PHOTO 8-4. Nonirrigated farmland. Wind erosion will be reduced by proper residue management.

PHOTO 8-5. Minimum tillage decreases energy useage, reduces wind erosion and improves infiltration.

Nonirrigated Cropland Management

Nonirrigated cropland management applies to dry land used for crops, hay production, and pasture. Management objectives include using all land within its capability, controlling wind and water erosion, and maintaining soil physical condition. These objectives can be met by returning land not suited for cultivation to permanent cover, or by using a sound cropping system with residue management, along with supporting measures, such as contour farming, contour terraces, and stripcropping.

Improved varieties, timely tillage, planting, and harvesting; good weed, insect, and disease control; and a good fertility program are needed for maximum production.

The development of all cropland to its optimum potential by 2020 would require increased expenditures of about $637,000. Returns would increase by about $3.54 million. Irrigated cropland would contribute about $2.55 million in increased returns, with an increase in land treatment costs of about $460,000. Dry cropland returns would increase about $990,000, and land treatment costs would increase about $167,000.

FOREST LAND TREATMENT

Forest land treatment systems have the potential to increase wood products, such as saw timber, pulp wood, fence posts, Christmas trees, and balled stock. Wildlife populations and recreation would be enhanced. Water quality and quantity would increase. There are about 1,236,000 acres of forest land with the potential to respond to land treatment.

PHOTO 8-6. Planting tree seedlings is usually required to reforest lands where fires, insects or disease have killed the timber. The Forestry Division can assist landowners in obtaining seedlings and in using the best planting techniques.

Forest land treatment systems are comprised of stand protection, stand management, and regeneration. Stand protection would include fire, insect, and disease protection. Some of the practices under stand management are marking, thinning, pruning, road maintenance, selective cutting, and inventory. Regeneration is the planting of improved stock on burned, logged or insect and disease killed areas.

PHOTO 8-7. Cattle grazing is a primary source of income for many forest land owners. The Soil Conservation Service provides range management planning assistance for landowners.

Application of land treatment measures on forest land to the maximum potential would result in increased timber growth of about 62.6 million cubic feet per year. The increased land treatment cost associated with this production is estimated to be $6 million per year in 2020. The increased return is estimated to be $11.3 million per year in 2020.

OUTDOOR RECREATION DEVELOPMENT

The basin has potential for recreation developments. People in the Basin prefer water-based recreation activities, as evidenced by visitation at Conchas and Ute Lakes. However, development of water-based recreation in the basin is limited.

There is one existing ski area. Additional areas suited for good, long season skiing appear to be limited.

Picnic and camping developments could be expanded throughout the forest areas. These facilities require considerable operation and maintenance expense to keep them in desirable condition.

No analysis was made of vacation cabins and guest lodges. These require relatively high capital investments and good management to be successful. Many of the private forest lands have an ideal setting for cabins and lodges. Based on the current number of out of state recreation visitors, there should be increased demand for these vacation facilities.

FISH AND WILDLIFE DEVELOPMENT

This basin contains some of New Mexico's better fish and wildlife habitats, which provide residents and visitors with hunting, fishing, and wildlife observing opportunities that are of high quality.

There are many opportunities for enhancing this important resource. They include:

1. Vegetative management practices will improve habitat for wildlife by providing greater food supplies and more protective cover. Larger wildlife populations can be supported.

2. Land treatment designed for erosion control and sediment retention will reduce the amount of sediment reaching streams and lakes containing fish. Spawning areas and food production will be improved.

WATER QUALITY

Improvement in water quality can be partially accomplished by treatment of critical sediment producing areas and improving irrigation system efficiencies.

There is a potential through the Environmental Improvement Division and federal programs of assistance to provide sewerage and solid waste management systems in many communities.

A decision on, or choice of a particular site should be based on hydrogeology and surface waters, cover material availablity, accessibility of site to collection vehicles including haul distances and travel time, and the presence or lack of public opposition.

ELECTRIC POWER

There is a potential for increasing electrical power through use of thermal, nuclear, solar, wind, and hydro resources. However, most of the needed electrical power will probably be imported from outside the basin because of limited water supplies.

CHAPTER 9

OPPORTUNITIES FOR DEVELOPMENT AND IMPACT OF USDA PROGRAMS

This chapter deals with evaluation of programs for development of water and related land resources for which the U. S. Department of Agriculture can provide assistance. Physical and economic impacts expected from the potential programs are shown.

A potential program evaluated for the Basin consists of accelerating the existing USDA program of land treatment and management, to commence in the year 1980.

Opportunities for land treatment in the Basin are discussed. Estimates include costs and expected returns for the period 1990-2020.

Opportunities for improvement of land and water resources by using the Resource Conservation and Development programs are identified. Development opportunities for the cooperative State and Private Forestry Programs and National Forest Development are also identified.

CHAPTER 9 OPPORTUNITIES FOR DEVELOPMENT AND INPUT OF USDA PROGRAMS

Page

TABLES

LAND TREATMENT UNDER USDA AUTHORITIES

Land treatment and/or management systems are logical combinations of applicable land treatment and management practices that are needed to correct problems or increase productivity on particular types of lands. Improved management, vegetative improvement, and mechanical treatment of the lands within the Basin can enhance the economy, as well as preserve the resource base. Land treatment systems can be planned and applied to increase the production of crops, forage, wood, water, meat, and reduce erosion and damaging sediment deposition.

The USDA River Basin Field Party described and estimated the results of an acceleration of the existing land treatment program in the Basin. The accelerated land treatment program was treated as one for which no new legislation would be required at the state and federal levels.

The estimates of an accelerated program's effects were determined by estimating: (a) the amounts of crop, range, and forest acreage to be directly affected; (b) the degree to which land treatment would be practiced in the affected areas; and (c) the per-acre cost changes and the productivity increases associated with land treatment.

Unlike the potential land treatment program mentioned in Chapter 8 that would fill all designated land treatment needs, the accelerated program is based upon the observed degree of willingness on the part of landowners and farm managers to participate in land treatment programs generally.

As the USDA considers extending assistance toward implementing various programs or projects, the estimates of program effectiveness take into account the part that farm managers, other landowners and managers will play. Effective land treatment programs are dependent upon the individual's response to desired program objectives. Therefore, assessing the following opportunites involved predicting the response of private landowners and managers to an accelerated land treatment program. The scale of this accelerated program was not directly related to the numerical quantities projected for the without-program condition in Chapter 4.

Cropland

The acceleration of the existing land treatment program was described in terms of management levels, the characteristics of those levels, and a projected timetable for arriving at those levels, assuming an implementation date of 1980.

For cropland, three levels of management, high, medium, and low, were considered. High level management results in production that is 80 percent or more of the maximum obtainable with contemporary technology. The level of management for dryland soils consists of:

(1) Using crops adapted to the soil and water supply;
(2) Using a cropping system capable of maintaining good soil physical condition;
(3) Managing crop residue in a way that effectively controls erosion;
(4) Maintaining optimum fertility level by applying fertilizer or by growing soil improving crops;
(5) Conserving moisture;
(6) Controlling insects, diseases, and weeds;
(7) Keeping tillage to a minimum and tilling only when the moisture content is such that compaction is minimized;
(8) Planting improved varieties;
(9) Practicing timely planting, tilling, and harvesting; and
(10) Using terraces, stripcropping, contour farming, and other erosion control practices where needed.

A high level of management for irrigated soils includes the above measures in addition to:
(1) Having an adequate supply of irrigation water;
(2) Using properly designed irrigation systems;
(3) Applying water according to the needs of crops and soils, and;
(4) Coordinating crops with water delivery and irrigation systems.

Medium level management results in production that is 60 to 80 percent of maximum obtainable with contemporary technology. This level of management includes application of most of the measures listed under high level management; however, one or more of the management measures needed to optimize yield and prevent soil deterioration are not applied. This level includes situations where irrigation water is inadquate for high production.

Low level management results in production that is less than 60 percent of the maximum obtainable with contemporary technology. This level of management employs some of the measures used in high level management. However, some measures needed for optimum or average yields are seldom or never applied and other measures are either inadequately or incorrectly applied. Soil deterioration generally occurs under this level of management.

TABLE 9-1. PROJECTED CROPLAND MANAGEMENT LEVEL WITH ONGOING AND ACCELERATED USDA PROGRAM BY PERCENT OF TOTAL ACRES OF CROPLAND

Management Level	1980	2000		2020	
		Ongoing	Accelerated	Ongoing	Accelerated
	%	%	%	%	%
High	15	20	30	25	40
Medium	60	65	60	65	55
Low	25	15	10	10	5

Source: Unpublished estimates by SCS State Office Agronomist and other SCS field specialists .

An accelerated USDA program would cause an increase in yields by providing: (1) additional funding of Extension Service Programs specifically directed toward crop production; (2) expanded cost-share programs for new soil and water conservation practices as these become available; (3) a higher cost-share rate for irrigation practices; (4) an increase in or removal of the maximum amount of cost-sharing assistance for irrigation practices; (5) acceleration of research directed for pest control, new varieties, and water conservation.

Other important USDA roles include encouraging land users to apply new technology, reduce erosion, and maintain the resource base.

Rangeland

For rangeland, all of the various possible levels of management were grouped into three broad classes, or levels, defined as follows:

Level 1 - This is considered a low level of treatment and low level of management. Under this alternative, heavy stocking rates are considered that result in 60 percent or better use of the present vegetation. Thus, additional substitute feeding would be necessary to achieve a calf crop of 75 to 80 percent to offset the stress placed on livestock due to lack of available forage. No additional water developments would be done to achieve better distribution.

Grazing units would be large pastures common to the northeast part of the state. There would be no brush management in those areas needing brush management or mechanical treatment of the grazing land to change the composition of the plant community to reduce runoff. If mechanical treatment is done, no grazing management or deferment would be used following the mechanical treatment. Year-long grazing would be practiced under this alternative.

It should be noted that this alternative is estimated to have the lowest cost per acre (about 78 cents in 1976 dollars).

Level 2 - Medium level of treatment and management. Under this alternative, there would be a moderate cost (about $1.88 per acre). The resource could improve slowly and result in moderate returns.

A moderate stocking rate would allow all of the range to be grazed, but with approximately 50 percent or less use of the primary forage species. Supplemental feeding may be necessary for 90 days to provide protein during and prior to calving, and shortly after calving to provide a suitable level of nutrition for mother cows.

Under this alternative, there would be additional water developments in the range unit in order to achieve distribution.

There would be more and smaller grazing units under this alternative. Systematic brush management or mechanical treatment of the range and/or reseeding, depending upon the ecosystem (soil and potential vegetation).

There would be deferred grazing with the above treatment. However, there would be year-long grazing when grazed and some erosion control.

Level 3 - The high level of treatment and management. There would be an increased cost per acre of about $2.32 and increased beef production per acre, as well as a maximum return per animal unit. In other words, this level would yield the most beef per acre and high animal performance, which results in the greatest net return.

With this alternative, a moderate level of stocking would achieve high animal performance. There would be only supplemental feeding as needed to meet the nutritional requirement at critical times for animals. The range improvement under this condition would allow a high nutrition level from the natural plant community.

Additional water developments and fencing would be necessary under this accelerated treatment to facilitate a rather intensive grazing system.

Brush management and mechanical treatment for reseeding, depending upon the ecosystem or the soil-vegetation associations, would be carried out in conjunction with the grazing system. Maximum improvement would be expected from this treatment and the greatest reduction in erosion and runoff. Deferred grazing would follow all treatment of the range. Erosion control measures would be practiced to bring about maximum reduction in runoff and sediment. Maximum efficiency of grazing would be obtained by the grazing system. This level would achieve maximum benefits from multiple use.

Estimates were made of rangeland area proportions likely to be governed by management groupings 1, 2, and 3 by the projection years 1990, 2000, and 2020, under the assumptions of the continuation of the ongoing program, and the implementation of the contemplated accelerated program as of 1980. Using this "timetable," estimates were made of the differences in range land beef cattle costs and returns that would arise as a result of implementing the accelerated program.

TABLE 9-2. PROJECTED RANGE MANAGEMENT LEVEL WITH ONGOING AND ACCELERATED USDA PROGRAM, BY PERCENT OF TOTAL ACRES OF RANGELAND

		2000		2020	
Management Level	1980 %	Ongoing %	Accelerated %	Ongoing %	Accelerated %
High	10	15	45	20	40
Medium	30	30	30	30	30
Low	60	55	25	50	30

Source: Unpublished estimates by SCS State Office Range Conservationist and other SCS field specialists.

Cooperative State and Private Forestry Programs

Treatment opportunities for development are in the fields of forest land management, tree stand improvement, tree planting, improved utilization, and marketing. There are approximately 1,167,000 acres of state and private commercial forest land in the Basin. Many of the landowners have highly productive timber lands but are not interested in managing for maximum forest products. The harvesting of sawlogs, poles, posts, fuelwood, and Christmas trees is usually secondary to livestock grazing, big game hunting, or recreation activities.

The amount of forest land in the AWR which is understocked is estimated to be in excess of 100,000 acres. The timber on this land was either heavily logged, burned by wildlfire, or killed by bark beetle epidemic.

The majority of the land has a low site potential for growing timber. Consequently, landowners cannot be assured a profit when investing in reforestation on the marginal timber growing sites. Management objectives should be to obtain good logging practices in order to provide for optimum natural regeneration.

There are an estimated 20,000 acres of forest lands which would be economically feasible for planting. Assistance to landowners for reforestation is available through the Forest Incentives Program, the Agricultural Conservation Program, and Cooperative Production and Distribution of Forest Tree Planting Stock Program (CM-4).

The acreage of forest land needing pre-commercial or commercial thinning is unknown. Commercial thinnings provide the landowner a return for a portion of the total of his investment in thinning. Thinning provides for the maximum growth rate for timber stands. On good sites, this could mean an increase in growth from less than 100 board feet per acre per year to around 250 board feet per acre per year. This would be an increase of growth value from approximately $2.00 to $6.00 per acre per year.

Other program opportunities for increasing timber yields include tree improvement, forest insect and disease management, cooperative forest fire prevention and suppression, cooperative forest management, improved harvesting, and sawmill improvement.

Within their capabilities, the Forestry Division provides assistance to private landowners for the opportunities listed above. The Division has district offices in Las Vegas and Ute Park. Presently, the demand for assistance exceeds their capability. The limiting factors have been State personnel ceilings and shortage of State funds to meet landowner demands for the cooperative programs. In a few cases, the programs have not been adequately funded at the Federal level. This situation currently exists in the Rural Community Fire Protection Program.

The two basic functions within the Forestry Division are:

(1) Protect all non-municipal and non-federal lands from wildfire and suppress such fires when they occur.

(2) Assist forest landowners with management, utilization, and marketing of their stands, in accordance with state laws and landowners' objectives and improve the utilization of forest products by the wood products industry.

State Forestry provides training and equipment to rural fire districts. There are approximately 30 fire protection agreements between landowners and the Forestry Division in the AWR Basin.

Other functions of the Forestry Division include:

Distribution of seedling trees to landowners for windbreaks and forest stand plantings; technical services to communities for tree planting, insect and disease control, etc., in parks and greenbelts and along streets and highways; cost-sharing provisions for forestry conservation measures under the Agriculture Conservation Program (ACP); cost-sharing funds to landowners for increasing future timber supplies and the Forestry Incentives Program (FIP).

TABLE 9-3. PROJECTED FOREST MANAGEMENT LEVEL WITH ONGOING AND ACCELERATED USDA PROGRAM, BY PERCENT OF TOTAL ACRES OF FOREST LAND

Timber Type	Management Level	1980 %	2000 Ongoing %	2000 Accelerated %	2020 Ongoing %	2020 Accelerated %
Mixed	High	5	15	25	25	35
Conifer	Medium	45	40	35	35	30
	Low	50	45	40	40	35
Ponderosa	High	40	60	70	70	80
Pine	Medium	50	35	25	25	15
	Low	10	5	5	5	5
Aspen	High	5	5	5	10	25
	Medium	5	25	35	40	30
	Low	90	70	60	50	45
Pinyon-	High	5	5	10	10	20
Juniper,	Medium	15	20	20	25	25
P. Pine	Low	80	75	70	65	55

Source: Unpublished estimates by Forest Service and river basin field specialists.

NATIONAL FOREST DEVELOPMENT AND MULTIPLE USE PROGRAMS

In 1975 the AWR Basin contained 209,068 acres of U. S. Forest Service administered lands. These include 26,771 acres of Carson National Forest, 45,885 acres of Santa Fe National Forest, and 136,412 acres of Kiowa National Grasslands.

Opportunities include better management and protection to increase production of water, wood, forage, recreation and wildlife, and improve environmental quality and maintain the quality of existing and proposed wilderness.

Timber

There are approximately 50,000 acres of National Forest commercial timberland within the Basin. This includes 16,000 acres on the Carson National Forest, and 34,000 acres in the Santa Fe National Forest. The majority of this has been logged one or more times. Opportunities exist for pre-commercial thinnings and commercial thinnings, reforestation of burns, and insect killed areas. These lands are important to residents of local villages and farms for cutting fuelwood, Christmas trees, vegas, and poles.

Water

National Forest lands in the AWR Basin are located in the headwaters of Coyote Creek, Colfax County; Mora River, Rio La Casa, and Rito de Gascon, Mora County; Manuelitas Creek and Sapello River, San Miguel County. Opportunities for increasing water yield in these watersheds are limited.

Possibilities include block and strip cutting of mixed conifer timber stands. Lands with wilderness classification have restrictions which prohibit timber harvest, vegetation manipulation, installation of snow fences, or other water management improvements.

Erosion control measures most needed on these National Forest lands are those related to road construction and maintenance. Roads are the primary source of sediment which affect downstream water uses.

Range

There are 65 individuals who have permits to graze a total of 350 head of cattle on the Carson and Santa Fe National Forests. These summer and fall permits provide much needed forage for the cattle owned by local residents. Intensive management offers the greatest opportunities to maintain and increase current forage production and livestock production. Other opportunities include water developments and fences.

The Kiowa National Grassland is located in the east-central portion of the AWR Basin. There are 136,412 acres administered by the Forest Service, with offices in Clayton.

The primary management objective of this grasslands program is to demonstrate that sound range management practices will provide stable soil conditions, improved water quality, increased beef production, and improved wildlife habitat. The District Forest Ranger works with the ranchers and the Soil Conservation Service to develop total ranch management plans. Currently, 65 ranchers have permits to graze 5,700 head of cattle on the Kiowa grasslands, for a total of 37,700 animal unit months.

Recreation

The only Forest Service developed recreation facilities are in Mills Canyon along the Canadian River. Although potential sites exist on the Carson and Santa Fe National Forests, there are no immediate plans for development. Dispersed recreation will be emphasized on the National Forests. There are private lands within and adjacent to the National Forests with good potential for developing camping and picnic sites.

Wildlife

There are opportunities for maintaining the quality of wildlife and fish habitat through coordination of other uses. To maintain the wildlife population at the highest level consistent with other uses of the land, management and treatment objectives must include improvements in the wildlife carrying capacity of the habitats.

Wilderness

There are 15,890 acres of the Pecos Wilderness within the AWR Basin. Six trail heads provide access to the wilderness from the Basin. In 1976, about 1,500 visitors entered via these trails.

The 1977 Roadless and Undeveloped Area Inventory includes lands immediately east of the Pecos Wilderness which may be considered, by Congress, as possible additions to the Wilderness system.

DESCRIPTION OF THE ACCELERATED FORESTRY PROGRAM

Most of the forestry programs on non-federal forested lands are implemented through cooperative agreements with the Forestry Division on a cost-share basis with the federal government. Some programs provide cost-share funds to the forest landowner and rural fire organizations.

Within the forests and woodlands the following opportunities exist:

1. Provide increased protection from man-caused and naturally occurring fires. This can be accomplished by increasing the fire prevention efforts, by improved fire detection, and by additional manpower and equipment for fire suppression.

2. Provide increased incentives and services to landowners for the implementation of good management practices. These could include some or all of the following:

    a. Use of harvest or cutting methods best suited to various forest stands.

    b. Use of logging and transportation system for the optimum utilization of trees and removal with least impact on other resources.

    c. Use of slash disposal methods to minimize fire hazards.

    d. Use of site preparation and planting or seeding methods best suited for establishment of regeneration.

    e. Use stand improvement practices which will maximize profits for the landowner.

3. Provide services to all forest landowners for the prevention and reduction of damage and loss caused by insects and diseases.

4. Provide services to urban and community forest lands for creating and maintaining a more attractive, healthful, and enjoyable place for people to live, work, and play.

MEANS OF IMPLEMENTING ACCELERATED LAND TREATMENT AND FORESTRY ASSISTANCE PROGRAM

The means of shifting from the present level of USDA land treatment program to an accelerated level is essentially to make more federal cost-sharing funds available and to add additional USDA personnel for detailed local treatment planning and increased educational and demonstration efforts. In the case of forest resources on non-federal lands, it would utilize additional state funds and personnel above the presently authorized levels.

RESOURCE CONSERVATION AND DEVELOPMENT PROGRAM - PUBLIC LAW 87-703

Many of the proposed "Opportunities for Development" listed in this chapter can be promoted and some can be partially financed under this program. These opportunities include (1) critical area treatment, (2) flood prevention, (3) farm irrigation (4) land drainage, (5) soil and water management for agriculture-related pollution control, (6) public water-based recreation and fish and wildlife, and (7) water quality management.

Other recommended project measures that could be developed under RC&D authorities in cooperation with other agencies are:

1. Marketing cooperatives.
2. Accelerated conservation planning on those lands proposed for intensive land treatment.
3. Improved crop production.
4. Community development needs, such as domestic water and sewage.
5. Forestry management, utilization, and processing assistance.
6. Encourage development of low water-consuming industries, such as pressed board or pressed wood plant, which would utilize sawmill residue now burned as scrap; firewood marketing, using scrap wood from sawmill operations; and growing, managing, and harvesting of Christmas trees.
7. Develop nature trails in selected areas.
8. Skiing facilities in the Eagle Nest area.

RURAL ELECTRIFICATION

It is recommended that local groups and interests make more use of the assistance available through Rural Electrification Administration loans. These loans enable members to purchase and install wiring, electrical, and plumbing equipment.

IMPACTS OF THE ACCELERATED PROGRAM

The impacts of the potential accelerated land treatment program are described in this section. Quantitative impacts are provided where possible. Many of the impacts can be described only in a qualitative manner. No attempt is made to indicate the importance of one impact relative to another.

PHYSICAL EFFECTS

The installation of the land treatment systems would have predictable physical impacts on the water and related land resources in the Basin. Impacts that would result from the accelerated land treatment program include increased water yield, reduction in sediment deposition, increased forage yields, reduction of soil nutrient losses, and increased crop production.

Implementation of the accelerated land treatment program on about 7,805,000 additional acres of land in the Basin, starting in year 1980, would provide significant physical impacts such as:

1. Estimated water yields and/or water savings would amount to about 85,000 acre-feet annually by year 2020, from improvement of irrigation systems. This is a 33 percent saving.

2. Sediment deposition in the Basin's rivers and reservoirs would be reduced by about 1,300 acre-feet annually by year 2020, an 18 percent reduction.

3. Sheet and gully erosion would be reduced by about 3,000 acre-feet annually by year 2020, an 18 percent reduction.

4. Crop production would be increased due to improved irrigation systems and increased efficiencies in management of land and water.

5. Beef cattle production would be increased by about 4,690 tons annually by year 2020, a 4.5 percent increase.

6. Timber stand improvement and cultural treatment accomplished for 1,236,000 acres by 2020 for increasing the increment of the stands.

ECONOMIC EFFECTS

By 2020, over nine million acres would be involved in some type of land treatment, as opposed to about seven million acres if no acceleration of the USDA's existing land treatment program is implemented.

The acceleration of the existing land treatment program for cropland, forests, and range is estimated by the River Basin Field Party to increase Basin public and private land treatment costs and output of agricultural products as shown in Table 9-4 below. Because the year 1980 is treated here as the commencement of the accelerated program, no 1980 effects are projected.

TABLE 9-4. INCREASE IN ANNUAL PUBLIC AND PRIVATE COSTS AND ANNUAL REVENUES FROM AGRICULTURAL OUTPUT DUE TO THE ACCELERATED PROGRAM (1976 DOLLARS)

	1990	2000	2020
Revenue Increase			
Livestock	$1,023,800	$2,047,600	$4,091,300
Crops	1,136,000	2,819,000	5,286,200
Forest Products	469,700	939,400	1,280,400
Cost Increase 1/			
Livestock	790,000	1,509,000	2,948,000
Crops	129,300	183,500	197,900
Forest Products	737,000	1,299,000	1,321,000

Source: River Basin Planning Staff

1/ Land treatment installation cost is the only significant component of these cost figures. The installation activity is expected to occur over the entire period 1980-2020.

Increased output other than the agricultural output projected to result directly from the program is estimated at $3,240,000 annually by year 2020.

Water yield increase and salvage from land treatment by year 2020 is estimated at 85,000 acre-feet annually. At an assumed value of $35 per acre-foot for irrigation purposes, it would be worth $2,975,000 (the value of increased water yield is incorporated into crop production value, and included under "Revenue Increase" in Table 9-4 above).

The forest products industries are expected to have an increased variety of products. Their annual production is estimated to increase by $1,280,400 annually by year 2020.

Table 9-5 shows the projected crop production in detail, with the accelerated land treatment program.

Crop acreages are not projected to change from their without-plan levels, shown in Appendix E, Table E-5.

TABLE 9-5. PROJECTED CROP PRODUCTION OF MAJOR HARVESTED CROPS, WITH ACCELERATED LAND TREATMENT PROGRAM; AWR BASIN NEW MEXICO

Crop Type	1980	1990 1/	2000	2020
Irrigated crops				
Cotton (bales)	720	360	0	0
Barley (bu)	111,580	138,600	165,630	217,290
Corn, grain (bu)	842,580	1,409,550	1,976,520	3,096,980
Corn silage (ton)	134,000	143,120	152,240	252,360
Sorgham, grain (bu)	1,413,970	1,419,320	1,424,670	2,323,010
Sorghum, silage (ton)	103,870	66,970	30,070	35,000
Wheat (bu)	777,750	962,400	1,147,050	1,948,550
Alfalfa hay (ton)	100,980	114,010	127,030	149,900
Other hay (ton)	26,410	26,740	27,070	33,160
Dryland crops				
Sorghum, grain (bu)	539,600	749,540	959,480	1,261,660
Sorghum, silage (tons)	102,780	90,340	77,890	82,840
Wheat (bu)	1,805,220	2,182,020	2,558,830	3,357,060

Source: River Basin Planning Staff

1/ Interpolation estimates

Table 9-6 shows the projected increases in crop production due to acceleration of the land treatment program. These increases are all expected to result from the effect of more intensive land treatment activity on crop yields. As more crop acreage is affected by increased land treatment activity, crop yields are projected to increase also.

Table 9-7 shows the projected amounts of livestock production with the accelerated program. The production amounts of livestock products other than beef cattle are not projected to change as a result of the accelerated program.

Table 9-8 shows the projected change in production of beef cattle resulting from acceleration of rangeland treatment.

TABLE 9-6. PROJECTED INCREASE IN CROP PRODUCTION DUE TO ACCELERATION OF LAND TREATMENT PROGRAM

	1990 1/	2000	2020
Irrigated Crops			
Cotton (bales)	0	0	0
Barley (bu)	3,120	6,230	18,930
Corn, grain (bu)	63,700	127,410	338,790
Corn, silage (tons)	5,420	10,840	28,860
Sorghum, grain (bu)	76,420	152,830	298,240
Sorghum, silage (tons)	1,070	2,140	4,000
Wheat (bu)	28,800	57,600	165,080
Alfalfa hay (tons)	4,080	8,150	16,380
Other hay (tons)	1,180	2,350	4,740
Dryland crops			
Sorghum, grain (bu)	34,620	69,240	153,780
Sorghum, silage (tons)	2,160	4,330	7,050
Wheat (bu)	91,890	183,780	403,140

Source: River Basin Planning Staff

1/ Interpolation estimates

TABLE 9-7. PROJECTED LIVESTOCK PRODUCTION 1/ WITH ACCELERATED LAND TREATMENT PROGRAM; AWR BASIN, NEW MEXICO

Products	1980	1990	2000	2020
		1,000 Units		
Beef and Veal (lb.)	206,789.5	210,117.8	213,446.1	218,106.9
Pork (lb.)	4,073.5	4,089.4	4,105.3	3,723.4
Lamb and Mutton (lb.)	393.2	326.0	258.9	287.7
Chickens (lb.)	142.9	164.6	186.3	219.1
Turkeys (lb.)	11,546.0	5,773.0	.0	.0
Eggs (doz.)	1,091.1	1,251.3	1,411.5	1,662.6
Milk (lb.)	14,269.2	15,220.0	16,171.8	19,025.6

1/ Production estimates for all livestock products except beef and veal are based upon OBERS projections of conditions without accelerated land treatment program. Beef and veal production provided by River Basin Planning Staff.

TABLE 9-8. PROJECTED CHANGE IN PRODUCTION OF BEEF CATTLE DUE TO ACCELERATED PROGRAM (IN THOUSANDS OF POUNDS)

	1980	1990 1/	2000	2020
Beef and veal	0	2,346.5	4,693.0	9,376.8

Source: River Basin Planning Staff

1/ Interpolation estimate.

Table 9-9 shows the projected value of crop production with the accelerated program, and Table 9-10 shows the projected value of livestock production.

TABLE 9-9 PROJECTED VALUE OF CROP PRODUCTION WITH ACCELERATED LAND TREATMENT PROGRAM; AWR BASIN, NEW MEXICO (1976 DOLLARS)

Crop Type	1980	1990 1/	2000	2020
Cotton	169,400	84,700	0	0
Barley	242,100	230,600	219,000	287,900
Corn, grain	2,317,100	3,876,300	5,435,400	8,516,700
Corn silage	1,608,000	1,717,400	2,371,800	3,028,300
Sorghum, grain	4,883,900	5,422,100	5,960,400	8,961,700
Sorghum silage	1,246,400	803,600	360,800	420,000
Wheat	8,601,300	10,470,900	12,340,600	17,667,700
Alfalfa	5,203,500	5,874,900	6,545,900	7,724,300
Other Hay	1,360,900	1,377,900	1,394,900	1,708,700
Other crops	207,400	218,600	229,700	254,800
Totals	25,840,000	30,077,000	34,858,500	48,570,100

Source: River Basin Planning Staff

1/ Interpolation estimates.

ACCELERATED PROGRAM PRODUCTION COMPARED WITH OBERS SERIES E

Table 9-11 shows the projected differences between OBERS Series E' and accelerated program production.

Projected OBERS production exceeds projected accelerated program production for cotton, sorghum grain, hay, (and wheat in 1980 and 2000).

The OBERS Series E' projected market share of AWR crop production, in 1976 dollar terms, is $35,342,200 for 1980, $47,803,800 in 2000, and $51,391,800 in 2020. This projected OBERS share exceeds the accelerated program's projected crop production value by $9,502,200 in 1980, $12,945,300 in 2000, and $2,821,700 in 2020.

TABLE 9-10. PROJECTED VALUE OF LIVESTOCK PRODUCTION WITH ACCELERATED LAND TREATMENT PROGRAM; AWR BASIN, NEW MEXICO (1976 DOLLARS)

Products	1980	1990 1/	2000	2020
Beef and veal	90,226,400	91,678,600	93,130,800	95,164,300
Pork	1,408,700	1,414,100	1,419,600	1,287,500
Lamb and mutton	128,900	106,800	84,800	94,300
Chickens	20,700	24,000	27,100	31,900
Turkeys	4,400	2,200	0	0
Eggs	734,700	842,700	950,600	1,119,700
Milk	1,558,300	1,662,000	1,765,900	2,077,500
Total	94,082,100	95,730,400	97,378,800	99,775,200

Source: River Basin Planning Staff

1/ Interpolation estimates

TABLE 9-11. DIFFERENCES BETWEEN PROJECTED OBERS PRODUCTION AND ACCELERATED PROGRAM PRODUCTION (MINUS AMOUNTS SHOW OBERS SMALLER THAN ACCELERATED PROGRAM PRODUCTION)

Commodities	1980	2000	2020
Cotton (bales)	1,720	2,190	2,190
Barley (bu)	0	-6,230	-18,930
Corn grain (bu)	-222,620	-1,496,780	-2,865,720
Silage (tons)	-122,900	-37,400	-150,420
Sorghum, grain (bu)	3,422,670	5,013,230	3,933,990
Wheat (bu)	297,110	560,900	-576,600
Hay (tons)	2,870	33,240	48,190
Beef cattle (lb)	1,196,400	63,868,500	83,713,100

Source: River Basin Planning Staff

In the livestock category, the OBERS projected value of beef cattle production is $90,748,400 in 1980, $105,873,100 in 2000, and $131,690,100 in 2020. This means that the size of the AWR market share projected by OBERS exceeds the projected accelerated-program beef-cattle production by $522,000 in 1980, $12,742,300 in 2000 and $36,525,800 in 2020.

The production and value of other types of livestock products is not projected to differ from their OBERS projected levels due to effects of the accelerated program.

VARIABILITY OF WEATHER AND FARM REVENUES

Farm revenues vary greatly from year to year in the Basin, mainly due to weather's effect on crop yields. Yields are affected by degree of cloudiness, timing of frosts, growing season temperatures, extent and distribution of precipitation over the year, insects and blights, and presence and severity of hail. Irrigated crops are not greatly affected by growing season precipitation, of course.

Even knowledge of the relationships between a few of these weather factors and yield levels would be of little use in predicting crop yields long before the beginning of any given crop planting season. Therefore, no attempt was made to find such relationships, or to establish their probabilities.

The main object in knowing the effect of weather variability on yields is to get an idea of how variable yields themselves are likely to be in the future. Accordingly, yield variability of dryland crops and crops irrigated with surface water supplies has been traced through a study of past records.

For drylands of the Basin, a conglomerate of wheat yield and sorghum yield was found to vary over the years as follows: The conglomerate yield, in dollars per acre, fell below 90 percent of its average level in about 28 percent of all years, 1957-1976. It fell below 80 percent of its average level about 17 percent of the time, and below 41 percent of the average level 17 percent of the time.

Representing past yields on cropland irrigated from surface water supplies is the record of yields for the U. S. Bureau of Reclamation's Tucumcari Project, in Quay County. The yield, in dollars of revenue, of a conglomerate of crops grown there, was studied and the frequency of years with yield declines was determined. The conglomerate of crops is as follows: Sorghum, alfalfa, silage, and cotton.

The conglomerate yield fell below 90 percent of its prevailing level in about 32 percent of all years from 1954 through 1975. It fell below 80 percent of its prevailing level about nine percent of the time, and below 70 percent of its prevailing level about five percent of the time. The yield declines are believed to be associated with some unfavorable aspect of weather that was not necessarily a lack of rainfall or irrigation water storage in reservoirs.

The accelerated program evaluated in this chapter is not expected to have a significant, predictable effect on yield variations caused by weather changes from year to year. However, to the extent that an accelerated program of land treatment can stave off an era of "Dust-Bowl" wind erosion conditions during years of future droughts, it is expected to limit long-term downward variations in yields.

INCOME AND EMPLOYMENT EFFECTS

For the installation of the land treatment measures, it is estimated that about 46 man-years of employment annually would be required by the year 2020. Primary wages created are estimated at about $414,000 annually.

Indirect effects in service-industry employment and increased annual earnings, as a result of increased production of agricultural and forest primary products, are expected to be 46 man-years and $1,065,000 by 2020, respectively. (See Table 9-12). Agricultural and forestry employment is not projected to increase significantly. (See Table 9-13).

TABLE 9-12. PROJECTED INCREASES IN EARNINGS FOR THE MAJOR BASIN INDUSTRY GROUPS RESULTING FROM DIRECT AND INDIRECT EFFECTS OF THE USDA ACCELERATED PROGRAM

(1976 Dollars) 1/

Industry Group	1990	2000	2020
Transportation, Utilities, and Communications	1,440	2,880	6,420
Wholesale and Retail Trade	1,290	2,580	5,960
Finance, Insurance, and Real Estate	950	1,900	4,400
Services	2,820	5,640	12,910
Contract Construction	1,970	3,940	6,750
Manufacturing	309,220	340,130	1,028,140
Agriculture	443,710	784,500	2,544,890
Total	761,400	1,141,570	3,609,470

Source: River Basin Planning Staff

1/ Excludes projected wages from land treatment installation.

TABLE 9-13 PROJECTED INCREASES IN EMPLOYMENT IN THE MAJOR BASIN INDUSTRY GROUPS RESULTING FROM DIRECT AND INDIRECT EFFECTS OF THE USDA ACCELERATED PROGRAM. 1/

Industry Group	1990	2000	2020
Transportation, Utilities, and Communications	0	0	0
Wholesale and Retail Trade	0	0	0
Finance, Insurance, and Real Estate	0	0	0
Services	1	1	1
Contract Construction	15	29	46
Manufacturing	31	26	45
Agriculture	0	0	0
Total	47	56	92

Source: River Basin Planning Staff

1/ Excludes projected employment for land treatment installation.

FOUR-ACCOUNT DISPLAY OF IMPACTS

The impacts of the USDA accelerated land treatment program are shown here in the form of a four-account display. The four different accounts are intended to show the gains and losses to individuals and society in four different spheres of program impacts, similar to the manner of an accountant's debiting and crediting in various accounts. The four accounts are: National Economic Development, Regional Development, Environmental Quality, and Social Well-being.

ARKANSAS-WHITE-RED RIVER BASIN
ACCELERATED LAND TREATMENT PROGRAM
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT 1/

Components	Measures of Effects (Average Annual) 1/
Beneficial effects:	
A. The value to users of increased output of goods and services	
1. Land treatment acceleration	
1990	$ 2,159,800
2000	4,866,600
2020	9,377,500
2. Accelerated forestry program	
1990	469,700
2000	939,400
2020	1,280,400
3. Utilization of unemployed and under-employed resources	
a. Land treatment	
1990	77,000
2000	154,000
2020	300,100
b. Forestry program	
1990	55,700
2000	111,400
2020	113,500
Total beneficial effects annually	
1990	2,762,200
2000	6,071,400
2020	11,071,500

Components	Measures of Effects (Average Annual) 1/
Adverse effects:	
A. The value of resources required for acceleration of existing program	
1. Project installation	
a. Land treatment	
1990	$ 772,200
2000	1,545,400
2020	2,998,800
b. Forestry program	
1990	556,900
2000	1,113,800
2020	1,135,300
2. OM&R	
a. Land treatment	
1990	7,700
2000	7,700
2020	7,700
b. Forestry program	
1990	5,600
2000	5,600
2020	5,600
3. Project administration	
a. Land treatment	
1990	139,400
2000	139,400
2020	139,400
b. Forestry program	
1990	180,000
2000	180,000
2020	180,000
Total adverse effects	
1990	1,661,800
2000	2,991,900
2020	4,466,800
Net beneficial effects	
1990	$1,100,400
2000	$3,079,500
2020	$6,604,700

1/ Price base 1976

Arkansas-White-Red River Basin
Accelerated Land Treatment Program
Environmental Quality Account

Component	Measure of Effects
Beneficial and adverse effects:	
A. Areas of natural landscape	1. Visual impact of the increase of grass, forb, and small shrub vegetation on about 6,597,500 acres of grazing land. 2. Visual impact of the removal of pinyon and juniper trees on 110,000 acres. 3. Visual change through the control of soil erosion on about 6,597,500 acres of grazing and recreational lands. 4. Visual impact of an increase of 5,840 new livestock watering developments, including windmills, on 9,425,000 acres of grazing land. 5. Visual impact of the construction of 9,425 miles of fence for 9,425,000 acres of grazing land. 6. Visual impact of construction of 264 erosion control structures for 9,425,000 acres of grazing land. 7. Visual impact of 11,542,700 cubic feet per year in timber growth on 1,236,000 acres of timberland. 8. Visual impact of defoliating 676,555 acres of mesquite and sand sagebrush.
B. Quality considerations of water, land, and air resources	1. Reduce soil erosion by about 3,000 acre-feet per year on about 4,712,500 acres of grazing land to protect and enhance the soil and productive capacity of the land for present and future generations. 2. Increase in the kind, amount, and vigor of vegetation improvement on about 6,597,500 acres of grazing land, 281,675 acres of cropland, and 926,100 acres of forest land. 3. Increased distribution of small water developments by about 5,840 with each serving about 1,610 acres of land on grazing land. 4. Increase crop residue left on the soil surface and mulching which improves the soil condition and provides additional protection from soil erosion on about 281,675 acres of cropland. 5. Reduction of 3,000 acre-feet of sediment annually will improve the water quality of the streams and rivers in the Basin. 6. Decrease in air particulate matter from better conservation on about 6,597,500 acres of rangeland and 281,675 acres of cropland.

C. Biological resources and selected ecosystems	1. An increase in the kind and amount of vegetation for livestock will also benefit pronghorn antelope and ground nesting birds on about 6,597,500 acres of grazing lands. 2. Increase distribution of permanent watering facilities for livestock that will be available to pronghorn antelope at about 5,840 new locations. Each new facility will serve about 1,610 acres. 3. Thinning of 110,000 acres of pinyon woodlands will increase herbaceous and woody forage production. Because of forage utilization by domestic livestock, wildlife habitat values will not increase significantly. In years of high mast production, thinned sites will produce large crops which will be available to both resident and transient wildlife. 4. The construction of about 9,425 miles of new cross fences on grazing lands will affect the movement of pronghorn antelope. 5. Defoliation by herbicide spraying of 676,555 acres of mesquite and sand sagebrush will produce new habitats which will increase populations of rodents, rabbits and ground nesting songbirds; while eliminating tree nesting sites utilized by songbirds, raptors and ravens. The loss of essential escape cover will degrade habitats for scaled quail. 6. Reduction of 3,000 acre-feet of sediment per year will improve aquatic habitat in the rivers and streams of the Basin.

ARKANSAS-WHITE-RED RIVER BASIN
ACCELERATED LAND TREATMENT PROGRAM
REGIONAL DEVELOPMENT ACCOUNT

Components	Measures of Effects AWR Basin	Measures of Effects Rest of Nation
Income:		
Beneficial effects:	(Average Annual) 1/	
A. The value of increased output of goods and services to users residing in the region		
1. Land treatment systems		
a. Cropland and range program		
1990	$2,159,800	
2000	4,866,600	
2020	9,377,500	
b. Forestry program		
1990	469,700	
2000	939,400	
2020	1,280,400	
2. Utilization of regional unemployed resources for land treatment installation		
a. Cropland and range program		
1990	77,000	$- 77,000
2000	154,000	- 154,000
2020	300,100	- 300,100
b. Forestry program		
1990	55,700	- 55,700
2000	111,400	- 111,400
2020	113,500	- 113,500
B. The value of output arising from external economies.		
1. Resulting from increased net returns due to land treatment		
a. Cropland and range program		
1990	551,600	- 551,600
2000	1,103,300	-1,103,300
2020	2,321,800	-2,321,800
b. Forestry program		
1990	334,900	- 334,900
2000	669,800	- 669,800
2020	912,800	- 912,800
2. Indirect and induced activity associated with utilization of regional underemployment and other labor resources for:		
a. Cropland and range OM&R	2,400	- 2,400
b. Forestry OM&R	3,300	- 3,300
Total beneficial effects		
1990	$ 3,654,400	$- 892,200
2000	$ 7,850,200	$-1,778,800
2020	$14,311,800	$-3,240,300

Components	Measures of Effects AWR Basin	Measures of Effects Rest of Nation
Income:		
Adverse effects:	(Average Annual) 1/	
A. The value of resources needed to achieve the outputs		
1. Land treatment acceleration		
a. Cropland and range program		
1990	$ 386,100	$ 386,100
2000	772,700	772,700
2020	1,449,400	1,449,400
b. Forestry program		
1990	278,400	278,400
2000	556,900	556,900
2020	567,700	567,700
2. Project administration		
a. Cropland and range program		
1990		139,400
2000		139,400
2020		139,400
b. Forestry program		
1990		180,000
2000		180,000
2020		180,000
B. Losses of output resulting from external diseconomies	0	0
Total adverse effects		
1990	664,500	983,900
2000	1,329,600	1,649,000
2020	2,067,100	2,386,500
Net beneficial effects		
1990	$ 2,989,900	$- 91,700
2000	$ 6,520,600	$- 129,800
2020	$12,244,700	$- 853,800

1/ Price base 1976

ARKANSAS-WHITE-RED RIVER BASIN
ACCELERATED LAND TREATMENT PROGRAM
REGIONAL DEVELOPMENT ACCOUNT

Components	Measures of Effects: AWR Basin	Measures of Effects: Rest of Nation
Employment		
Beneficial effects:		
A. Increase in number of jobs		
1. Agricultural employment		
1990	0	-
2000	0	-
2020	0	-
2. Employment in land treatment construction		
a. Cropland and range		
1990	9	-
2000	17	-
2020	33	-
b. Forestry program		
1990	6	-
2000	12	-
2020	13	-
3. Employment in OM&R	0	-
4. Indirect and induced employment for output of project's goods and services		
1990	32	-32
2000	27	-27
2020	46	-46
Total beneficial effects, in number of persons employed annually		
1990	47	-32
2000	56	-27
2020	92	-46

Components	Measures of Effects: AWR Basin	Measures of Effects: Rest of Nation
Employment		
Adverse effects:		
A. Decrease in number and type of jobs	0	-
Total adverse effects	0	-

Arkansas-White-Red River Basin
Accelerated Land Treatment Program
Social Well-Being Account

Component	Measures of Effects
Beneficial and adverse effects:	
A. Employment effects	Creates 47 jobs for area residents by year 1990 and 92 jobs by 2020.
B. Life, health and safety	Significantly reduces vulnerability of soils to wind and water erosion, with resulting unquantified but positive effect of: (1) decreasing citizens' uncertainty about future possible loss of the agricultural resource base, and (2) raising respiratory health level due to reduced level of airborne soil particles.

CHAPTER 10

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Some of the potential developments are not now feasible or applicable under existing USDA programs, and for others water is not available. Some of the existing and projected needs may be met by other authorities, but some will require new legislation and authority for development. Also, there may be alternative methods for solving some of the problems. Resource Conservation and Development Committees, Four-Corners Development Commission, and area planning organizations, such as the councils of government, can coordinate and put into action some of the projects and programs that will help to meet some of the basic needs. Some of the conservation practices involve private lands, and new authorities may be needed if they are to be accomplished.

CHAPTER 10. COORDINATION AND PROGRAMS FOR FUTURE DEVELOPMENT

Some measures beyond the scope of this study and report should be considered for further utilization and development of the Basin resources. Some of these measures are being studied by research organizations. Projects and programs of other agencies have an impact on resource use and development, and they must be considered in future planning.

Continued cooperation is essential among all agencies involved in water resource conservation and development activities. Coordinated planning efforts can help to avoid conflicts among users of the basin's resources.

A L T E R N A T I V E   A P P R O A C H E S

FLOOD INSURANCE

Flood control by structural measures cannot be economically justified under Public Law 83-566 under current conditions. Flood Insurance is available, through the U.S. Department of Housing and Urban Development (HUD), for some communities recieving flood damage. Insurance is not a prevention against damages, but a means by which losses from flooding might be recovered. Flood hazard and flood insurance studies are a means of providing information to communities about flooded areas.

Communities that might consider this method of covering losses are: Springer, Raton, Cimarron, Tucumcari, Clayton, Logan, and San Jon. The Counties of Mora and Colfax are currently eligible for the insurance coverage.

WATER IMPORTATION

Water is not available for the development of all potential projects in the basin. If potentials are fully developed, water will have to be imported. There are about 6.5 million acres of additional land with soils and topography suitable for irrigation. To develop this land would require about 19 million acre-feet of water annually.

There are 29 sites with suitable topography for reservoirs. If water should be available these could be developed for recreation and fish and wildlife and some could provide supplemental irrigation water storage.

Long range planning for this type of development must include possible water importation.

WEATHER MODIFICATION

Weather modification may offer possibilities of increasing the amount of precipitation. Weather modification studies have been conducted by the federal goverment and private companies. These studies included the application of silver iodide to clouds from planes and by ground-based generators, dusting clouds with dry ice (carbon dioxide), and spraying water into clouds from airplanes. Experiments have proven

that for certain conditions, in some localities, precipitation can be increased by 20 percent by seeding clouds with silver iodide. Conditions in the basin may not be favorable for increasing precipitation. More research is needed before full-scale use is planned.

WATER YIELD

Some research has shown that supplies to tributary inflow and ground water can be increased by watershed treatment. To date, most research has been conducted on limited areas and the results are not conclusive that a net yield can be achieved over an extended period. Feasibility is presently limited by high costs, inadequate knowledge of specific methods applicable to a given area, and a lack of information about what effects extensive treatments would have on other resources and their uses.

In Colorado, research has attempted to evaluate water yield improvement using various techniques in alpine areas similar to the Tushar Mountains and Wasatch Plateau. Intentional avalanching may remove snow from an exposed place where it is rapidly melted to a shady protected place where its melt is retarded. Materials can be placed on the snow surface to either increase or retard the melting rate. Snow fences intended to increase accumulation were evaluated and found to be effective only at carefully selected sites. For example, snow accumulation on two sites behind eight-foot fences added approximately one acre-foot of water for each 100 to 125 feet of fence (Martinelli, M., 1966).

Potential water yield increases resulting from conversion of aspen stands to grass cover were estimated to be three inches based on average conditions (Select Committee on National Resources, United States Senate). On oak brush and pinyon-juniper areas where precipitation is less, however, research has not conclusively found that stream flows can be increased by conversion to a grass cover. There are some indications that soil moisture and groundwater supplies may be improved through such treatment.

There is danger in applying specific research findings to other areas where conditions may differ. Detailed investigations should be carried out for a specific area to determine feasibility of water yield improvements before major projects are attempted.

CHANGE IN WATER USE

An economic alternative to the present use of water in the basin is to change to uses that produce higher returns. Any change in the place or purpose of use would have to comply with New Mexico statutes governing the appropriation and use of public waters. Due to social or cultural pressures, this alternative may not be acceptable, although it is economically sound.

RANGE BANK PROJECT

An alternative approach to rangeland protection would be a program similar to the "soil bank" program of several years ago. A "range bank" approach would differ in that rangelands would be retired for a period of years until vegetation could be re-established and erosion and sediment control facilities could be installed. This would be a program that could be extended indefinitely for rangelands where grazing was not in the best interest of the public. This would be especially applicable on some critical sediment source areas.

LAND USE REGULATIONS

There is a need for regulations that permit county-wide and state-wide land use planning. Land use plans need to be developed to cope with future population and economic expansion in the area. Responsibility for this type project lies with county, municipal, state, and federal planners. Zoning should be based on consideration of soils, topography, flood hazard, etc. Zoning and other regulations are necessary in certain areas to protect property owners from suffering floodwater losses and for more orderly development of their resources. Often certain regulations are required before an area is eligible for flood insurance. Flood hazard information may be furnished through programs of the U.S. Department of Housing and Urban Development, the Soil Conservation Service and the Corps of Engineers.

FLOOD PROOFING AND RELOCATION

In areas subject to flooding where homes or other buildings have been constructed, flood proofing and relocation may be the most practical solution to reducing floodwater damages. Flood hazard analysis under USDA, U.S. Geological Survey, and the U.S. Army Corps of Engineers can be most effective in preventing future increases in flood damages, especially when these programs are supported by land use regulations. Usually individuals, groups, or municipal governments are responsible for flood proofing and relocating their buildings.

POLLUTION CONTROL

Improved land treatment and use, regulation of waste disposal, needs to be implemented. The 208 planning effort undertaken by the New Mexico Environmental Improvement Division will identify sources of pollution and plan measures to control the pollution. Sites for solid waste disposal need to be developed in the vicinity of communities. Counties and the communities will have to implement this type of program.

WILD AND SCENIC RIVERS

The State Planning Office has proposed a study to identify and preserve rivers or sections of rivers having outstanding scenic beauty. An interim proposal for classification under a State Wild and Scenic River System includes a 14 mile segment of the Cimarron River.

PHOTO 10-1. Canadian River near Sabinosa.

ARCHEOLOGICAL AND HISTORICAL

State and local government agencies and interested organizations need to cooperate in the indentification and protection of archeological and historical resources. Public funds should be made available to identify and protect the most valuable sites from deterioration or destruction.

LAND TREATMENT

USDA programs are planned to furnish accelerated technical assistance for installing land treatment practices and for conservation planning assistance. Some funds are planned for cost-sharing assistance. This leaves the job of decision making and installation to landowners or operators. To accomplish the plans for land treatment, farmers must make land use adjustments. State and federal agencies should work together to provide assistance in management of wildlife areas, and protecting environmental values.

CRITICAL AREA TREATMENT

USDA programs can provide technical and financial assistance to landowners and operators to control and restore critically damaged areas.

STRUCTURAL MEASURES

USDA programs can assist in planning, designing, and financing some of the structural measures. Initiative by individuals, groups, organizations, counties, municipalities, and state agencies is the key to success of any of the projects or programs.

WATER SUPPLY AND DISTRIBUTION

Cities, towns, and rural communities must make long-range plans to meet their water needs. They must agree on the location of future development and work out methods of financing. Councils of government will provide important planning assistance to these areas. Grants and loans may be available from other federal agencies.

OTHER AGENCY PROGRAMS AND THEIR IMPACTS

Other federal and state agencies have programs designed to develop water and land resources and to improve the economic well being of the people. Some of the benefits of these programs are very evident. The Tucumcari Irrigation Project operated and maintained by the Arch Hurley Conservancy District was completed in 1950. The project works consists of Conchas Dam and Reservoir and about 55 miles of canal. The project was constructed by the U.S. Bureau of Reclamation. The main Conchas Canal has a high seepage loss and needs to be lined with an impervious lining.

The New Mexico Environmental Improvement Division (EID) has developed on- going programs of research, education, information, and enforcement in such water and related land fields as water quality, water supply, water control, and solid waste management. The EID administers the Sanitary Projects Act which provides technical and monetary aid to small, established communities for developing community water supplies. The agency is also instrumental in coordinating federal water quality programs with state needs.

Some of these authorities meet local and emergency situations only; others deal with problems that are essentially basin-wide. More complete development of the basin's resources might be attained through better authorities, financing, and coordinated efforts between local interests and water resource development agencies.

INTERAGENCY COORDINATION

Under existing USDA authorities, watershed protection, flood prevention, and land treatment projects must be planned, installed, and coordinated with the plans and projects of the Bureau of Reclamation, Corps of Engineers, Bureau of Land Management, and other interested agencies.

Future resource development projects should have interagency coordination to insure that feasible features from all programs are included to make the most beneficial use of all resources. This coordination may range from informal contacts between individuals to formal liaison between organizations and agencies.

BIBLIOGRAPHY

1. Martinelli, M., Possibilities of Snowpack Management in Alpine Areas, Pergamon Press, Oxford and New York, 1966.

2. Select Committee on National Resources, United States Senate, Eighty-Sixth Congress, Water Resourced Activities in the United States--Evapotranspiration Reduction, 1960.

APPENDIX A

GLOSSARY

GLOSSARY

Abbreviations

AF	ac. ft. Acre-foot
AF/Y; AFY	Acre-feet per year
AUM	Animal unit month
ASCS	Agricultural Stabilization and Conservation Service
AWC	Available water capacity
BIA	Bureau of Indian Affairs
BF	Board foot
BLM	Bureau of Land Management
BOD	Biochemical oxygen demand
CFS	Cubic feet per second
DMU	Deer month use
EQ	Environmental Quality
ESCS	Economic, Statistics and Cooperatives Service
ETP	Evapo-Transpiration
FmHA	Farmers Home Administration
FS	Forest Service
GPM	Gallons per minute
LRA	Land Resource Area
MBF	Thousand board feet
Meg/l	Milliequivalents per liter
Mgd	Million gallons per day
Mg/l	Milligrams per liter
MmBF	Million board feet
NED	National Economic Development
OBERS	Office of Business Economics and Economic Research Service
pH	A unit of measure for hydrogen ion concentrate
PL	Public law
P&S	Principles and Standards
PPM	Parts per million
RD	Regional Development
RC&D	Resource Conservation and Development Program
RECP	Rural Environmental and Conservation Program
SAR	Sodium Absorption Ratio
SCS	Soil Conservation Service
SWCD	Soil and Water Conservation District
SWB	Social Well-Being
TDS	Total dissolved solids
USBR	U. S. Bureau of Reclamation
USDA	U. S. Department of Agriculture
USDI	U. S. Department of Interior
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey

Terms

ACRE-FOOT - The volume of water which will cover an area of one acre to a depth of one foot.

ACTIVITY DAY - A statistical unit of recreation use by one person in pursuit of a single activity for all or a part of one 24-hour period (SEE RECREATION DAY).

ADEQUATELY STOCKED AREAS - Commercial forest land, 40 to 70 percent stocked with trees.

AGGREGATE - Any of several hard, inert, construction materials (such as sand, gravel, shells, slag, crushed stone, or other mineral material), or combinations thereof, for use in concrete, road ballast, etc., or various manufacturing processes.

ALLOWABLE CUT - Harvestable trees in forest management.

ALLUVIAL FAN - A fan shaped land form resulting from water borne sediment deposition.

ALLUVIUM - Water borne sediment.

ALPINE - High elevation plant zone, hence cold.

ANIMAL-UNIT - Considered to be one mature (1000 lb.) cow or the equivalent based upon average daily forage consumption of 26 lbs. dry matter per day.

ANIMAL-UNIT MONTH (AUM) - (1) The amount of feed or forage required by an animal-unit for one month. (2) Tenure of one animal-unit for a period of one month.

ANNUAL - Occurring once during, or accumulated over, a consecutive 12 month period of time for which the beginning date is identified.

AQUIFER - A permeable geologic formation which stores and transmits water.

ARGILLIC HORIZON - A diagnostic horizon used in soil taxonomy. Subsurface horizon into which clay has moved.

ARID - Regions or climates that lack sufficient moisture for crop production without irrigation. The limits of precipitation vary considerably according to temperature conditions, with an upper annual limit for cool regions of 10 inches or less and for tropical regions, as much as 15 to 20 inches.

ARIDISOL - A classification order in soil taxonomy.

AVAILABLE WATER CAPACITY - Water retained by soil that can be used by plants.

AVERAGE ANNUAL BENEFIT - Uniform annual equivalent of project benefits for a specified time period and interest rate.

AVERAGE ANNUAL COST - Uniform annual equivalent of project costs for a specified time period and interest rate.

AVERAGE ANNUAL PRECIPITATION - The average yearly value of precipitation.

BASE PERIOD - A period of time specified for the selection of data for analysis.

BENEFICIAL EFFECT - A favorable change generated by a program or project.

BENEFICIAL USE OF WATER - The use of water for any purpose from which recognized benefits are derived, such as domestic, irrigation, or industrial supply, power development or recreation.

BENEFIT COST RATIO - The average annual benefits, in dollars, divided by the average annual costs.

BOARD FOOT - A unit of measure of the wood in lumber, logs, bolts, or trees; it is the amount of wood in a board 1 foot wide, 1 foot long, and 1 inch thick before surfacing or other finishing.

BRUSH - A growth of shrubs or small trees.

BRUSH CONTROL - Suppressing of brush to reduce its competition with more desirable species.

BRUSH MANAGEMENT - Management and manipulation of stands of brush to achieve specific management objectives.

CARRYING CAPACITY - (1) The maximum stocking rate possible without inducing damage to vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production. (2) The optimum density of a given wildlife species which a given environment or range is capable of sustaining permanently.

CHISELING AND SUBSOILING - Loosening the soil to break up layers of soil below the normal plow depth that inhibit water movement or root development. The soil is not turned over as in plowing and there is a minimum of surface soil mixing.

COMMERCIAL FOREST LAND - Forest land that is producing or is capable of producing crops of industrial wood (20 cu. ft. or more/ac./yr. capability) and is not withdrawn from timber use by statute or administrative regulation.

COMPREHENSIVE PLAN - A plan for water and related land resources development, that considers all economic and social factors and provides the greatest overall benefits to the region as a whole.

CONIFEROUS FOREST LAND - All conifer covered land except those urban-industrial areas having residual conifer cover.

CONSUMPTIVE USE (WATER) - The quantity of water discharged to the atmosphere or incorporated in the products in the process of vegetative growth, food processing, industrial process, or other use.

CONTAMINATION (WATER) - Impairment of the quality of water sources by sewage, industrial waste, or other matters to a degree which creates a hazard to public health.

CONTOUR FARMING - Conducting field operations, such as plowing, cultivating, and harvesting on the contour.

CRITICAL AREA PLANTING - Establishing vegetative cover to stabilize severely eroded areas.

CROP AND PASTURE DAMAGE - Damages such as crop loss or reduced yield, quality or life span; increased production costs resulting from flooding, spreading of diseases, and weed infestation; the inability to grow crops best adapted to the area; and losses due to suspension of irrigation water delivery or other loss of water.

CROP RESIDUE USE - Use of that portion of the plant or crop left in the field after harvest for protection or improvement of the soil.

CROP ROTATION - The growing of different crops in recurring succession on the same land.

CROPLAND - This is essentially composed of lands presently used for the production of both irrigated and non-irrigated crops and for pasture.

CUBIC FOOT PER SECOND (cfs) - Rate of fluid flow at which 1 cubic foot of fluid passes a measuring point in one second.

DECLARED UNDERGROUND WATER BASIN - The waters of underground streams, channels, Artesian basins, reservoirs, or lakes having reasonably ascertainable boundaries are public waters and are subject to appropriation for beneficial use. The State Engineer may assume jurisdiction over the appropriation and use of the waters of an underground water basin by issuing an order proclaiming the basin and describing its boundaries. In general, the State Engineer declares a basin when it appears that new appropriations of water might impair existing rights.

DEEP PERCOLATION - Water that percolates below the root zone and cannot be used by plants.

DEMAND - The quantity of a service, commodity, or resource that will be utilized when the price of providing it is considered.

DEPLETION (GROUND WATER) - The withdrawal of water from a ground water source at a rate greater than its rate of recharge, usually over a period of several years.
(WATER) - The water withdrawn that is no longer available because it has been either evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment.

DEVELOPED RECREATION - This use includes all lands classified or otherwise designated primarily for outdoor recreation use. National recreation areas, national parks and monuments, scenic areas, and state parks are included as "developed". These areas would also include public and private campgrounds, picnic sites, winter sport sites, resorts, etc., where recreation is the primary management objective.

DEVELOPMENT FACTORS - Development factors are the projection of economic growth (such as residential, commercial, agriculture, public facilities, etc) to the various time frames. These factors are based on population projections, employment, per capita income, recreation demand, etc.

DISCOUNT RATE - A percentage rate by which future estimated project benefits are required to be reduced for comparison purposes.

DISTURBED AREA PROTECTION - This measure may include any of the treatment and structural measures. In addition, it often includes stabilizing steep slopes, lining road ditches, construction of diversion structures, and temporary structural measures which permit regrowth of native or planted vegetal protective cover.

DOMESTIC USE - Water used normally for residential purposes, including household use, personal hygiene, and drinking, and normal outside uses such as car washing, swimming pools, and for lawns, gardens, and shrubs.

DRAINAGE - (1) The processes of the discharge of water from an area of soil by sheet or streamflow (surface drainage) and the removal of excess water from within soil by the downward flow of water through the soil (internal drainage). (2) The means for effecting the removal of water from the surface of soil and from within the soil.

DRAINAGE BASIN - The area that gathers water originating as precipitation and contributes it to a given point or location on a stream channel.

DRAWDOWN - The magnitude of lowering of the surface of a body of water or of its piezometric surface as a result of withdrawal or the release of water therefrom.

DRYLAND (FARMING) - Non-irrigated cropland.

DUNELAND - Hills or ridges of particles drifted and piled up by the wind so recently that no soil horizons have developed.

ECOLOGICAL IMPACT - The total effect of a change, either natural or man-made, in an environment upon the ecology of the area.

ECOLOGY - The study of the interrelationships of organisms to one another and to the environment.

ECONOMIC BASE - The economic characteristics (e. g., quantities of resources, export demand for products, supply of investment goods, quantity and quality of labor force, marginal capital-output ratio, production relationships, state of development of the region) that contribute to the region's income and growth and economic trends and cycles of the region. The economic base refers mainly to activities which produce and distribute goods and services for export.

ENDANGERED SPECIES - Fauna or flora which have a legal designation under state or federal statutes.

ENHANCEMENT - A condition resulting from the development of a project, program or activity, such that the value of the existing resources is greater than that which existed before the project, program or activity.

ENVIRONMENTAL QUALITY - An evaluation term for an account used in the Four-Account System of evaluation. It shows environmental effects of program actions.

EOLIAN - Of or borne by wind, as dunes. Also spelled aeolian.

EPHEMERAL STREAM - A stream that flows only in direct response to precipitation, and thus discontinues its flow during dry seasons.

EROSION - (1) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. (2) Detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

EVAPOTRANSPIRATION - The process by which water is transpired by plants and evaporated from the plant and surrounding surfaces.

EXISTING SUPPLY (RECREATION) - The total acreage of recreation areas that were operational in 1965. Data were derived from the Bureau of Outdoor Recreation's Nationwide Plan inventory and the National Association of Soil and Water Conservation District's inventory of private enterprises supplemented by information from management agencies.

EXTERNAL DISECONOMIES - Adverse effects that occur to individuals, groups, or industries which may or may not participate in the direct input to a project or plan.

EXTERNAL ECONOMIES - Beneficial effects that occur to individuals, groups, or industries which may or may not participate in the direct output of a project or plan.

FIREBREAK - A lane or strip devoid of vegetation which passes through flammable forest, brush, or grass fuels. It may be (1) constructed specifically for fire control, (2) a highway, (3) natural barren area, or (4) bodies of water.

FIRE PLAN - A plan for the operation and use of a fire protection system which is designed and sized to meet specific protection objectives. Part of the plan is usually an inventory of the existing system accompanied by an estimate of the size of system needed to meet the protection objectives. Such plans are usually for a period of about 5 years.

FIRE PROTECTION DISTRICT - A geographic area with delineated boundaries from which taxes are collected for the sole purpose of providing fire protection. The area is formed without consideration of political boundaries such as cities, counties, or other special districts. When accepted by the appropriate state authority, such Districts are legal governmental entities. They sometimes contract with the State to discharge State's fire protection responsibility on lands of state and national interest.

FIRE PROTECTION SYSTEM - The complete organization necessary to protect designated areas from damage by fire. Such a system includes statutory and administrative laws and authority, fire prevention and education efforts, all support functions and main elements of the fire control forces, and cooperative-mutual aid contracts and agreements between agencies.

FIRE RETARDANTS - These are slurries or viscous solutions usually dropped from airplanes on wildfires. They build a blanket of water on fuels and have a chemical blanketing effect when the water evaporates. Two major retardants in use in this region are diammonium phosphate with a sodium carboxymethylcellulose thickener and ammonium sulphate with an attapulgite clay (Bentonite) thickener. Both types are fertilizers.

FIRE SEASON - The season of the year when forest and brush fuels are cured out and highly flammable and when annual grasses have matured, died, and cured to a highly flammable state. In the Basin, this period covers late spring, summer, and early fall.

FISH HABITAT - Aquatic environments capable of supporting representative communities of fish species.

FLOOD FORECASTING - Flood forecasts are primarily the responsibility of the National Weather Service of the National Oceanic and Atmospheric Administration and are used to predict flood stages and indicate areas subject to flooding.

FLOOD FREQUENCY - The average interval of time between floods or percent chance equal to or greater than a specified discharge or stage. It is generally expressed in years.

FLOODPLAIN - The relatively flat area adjacent to rivers or streams subject to overflow.

FLOODPLAIN INFORMATION REPORTS - The Corps of Engineers assists State agencies and local governments throughout the nation by preparing floodplain information reports outlining flood conditions, and providing technical assistance in use of the data.

FORB - A broadleaf herbaceous plant.

FOREST AND RANGE FACILITIES DAMAGE - Damages to recreation facilities, fences and corrals, fish and wildlife facilities, roads, trails, and bridges, and forestry administration facilities.

FOREST AND RANGE RESOURCES DAMAGE - Losses or reduced yields from timber, brush, range, and creek bottom meadow lands; reduced fish and wildlife habitat.

FOREST FIRE - A wildfire originating in forest, brush, or grass fuels or a wildfire originating from structures, vehicles, debris burning, or other non-vegetative source that burns more than 1/4 acre of vegetation.

FOREST LAND - Land at least 10 percent stocked by forest trees of any size or formerly having had such tree cover and not now developed for non-forest use. Chaparral and mountain brush areas are included.

FOUR-ACCOUNT SYSTEM - An economic and environmental analysis that considers four principal spheres or program impacts, National Economic Development, Environmental Quality, Regional Development and Social Well-being.

FRAMEWORK PLAN - An assessment of the ability of a Region to meet the needs of assumed projected levels of population growth and economic development. Present uses are identified and available resources compared with estimated needs to the year 2020. Meeting needs developed under the direction of the Water Resources Council represents a conceptual way of planning to meet designated needs.

FUELBREAK - Strips, usually 50 to 350 feet wide, in which flammable fuels have been modified, reduced or thinned to provide the fire control forces with a safer place to work and to reduce wildfire intensity if it burns into the strip. A firebreak is included within the fuelbreak.

FULLY STOCKED AREAS - Commercial forest land, 70 percent or more stocked with growing-stock trees.

GAGING STATION - A station to measure water level or water quality parameters in a stream, reservoir pool, lake, or tidal basin.

GALLONS PER CAPITA (GPC) - A term used relative to water requirement per person per specified time, usually a day.

GRAZABLE WOODLAND - Forest land on which the understory includes, as an intergral part of the forest plant community, plants that can be grazed without significantly impairing other forest values.

GRAZING LAND - All lands presently being grazed by livestock within grass, brush, and forest cover types, excluding irrigated pasture.

GROSS EROSION - The total erosion from all sources at all points within a study area. Contrast to sediment yield.

GROSS WATER YIELD - The available water runoff, both surface and subsurface, prior to use by man's activities, use by phreatophytes, or evaporation from free water surfaces.

GROUND WATER - Underground water that is in a zone of saturation.

GROUND WATER BASIN - A ground water reservoir together with all the overlying land surface and the underlying aquifers that contribute water to the reservoir. In some cases, the boundaries of successively deeper aquifers may differ in a way that creates difficulty in defining the limits of the Basin.

GROUND-WATER MINING -See DEPLETION (GROUND WATER)

GROUND-WATER RECHARGE - Inflow to a ground water reservoir.

GROUND-WATER RESERVOIR - An aquifer or aquifer system in which ground water is stored. The water may be placed in the aquifer by artificial or natural means.

GROUND-WATER STORAGE CAPACITY - The reservoir space contained in a given volume of deposits. Under optimum conditions of use, the usable ground water storage capacity volume of water that can be alternately extracted and replaced in the deposit, within specified economic limitations.

GROWING SEASON - The average number of days exceeding 32 degrees F.

GULLY EROSION - The erosion process whereby water flows in narrow channels, and over short periods, removes the soil from such channels to considerable depths. The flow is ephemeral in nature. See ephemeral stream.

HARDNESS (WATER) - Characteristic of water due primarily to calcium and magnesium salts. This characteristic is generally evidenced by inability to develop suds when using soap. Durfor and Becker (1964) suggested the following classification:

Range of Hardness (mg/l)	Classification
0-60	soft
61-120	moderately hard
121-180	hard
More than 180	very hard

IGNEOUS ROCK - A rock or mineral that solidifies from molten or partly molten material. Igneous rocks constitute one of the three main classes into which all rocks are divided (i.e. igneous, metamorphic, and sedimentary).

IMPOUNDMENT - Generally an artificial collection and storage area for water.

INDUSTRIAL WATER - Water used for manufacturing or processing activities by an industrial establishment.

IRRIGABLE LANDS - Lands having soil, topography, drainage, and climatic conditions favorable for irrigation and located in a position where a water supply is or can be made available.

IRRIGATED CROPLAND - All lands being supplied water by artificial means, excluding waterfowl refuges, that are being used for the production of orchard, field, grain crops, and pasture.

IRRIGATION APPLICATION EFFICIENCY - Percentage of irrigation water applied to an area that is stored in the soil for crop use.

IRRIGATION DEPLETION - See DEPLETION (WATER).

IRRIGATION WATER REQUIREMENT - Quantity of water, exclusive of effective precipitation, that is required for crop production.

IRRIGATION RETURN FLOW - Applied water which is not consumptively used and returns to a surface or ground water supply. See also RETURN FLOW.

IRRIGATION WATER MANAGEMENT - The use and management of irrigation water where the quantity of water used for each irrigation is determined by the available water capacity of the soil and the need for the crop, and where the water is applied at a rate and in such a manner that the crop can use it efficiently and significant erosion does not occur.

IRRIGATION WATER REQUIREMENT - Quantity of water, exclusive of effective precipitation, that is required for crop production.

LAND CAPABILITY CLASSIFICATION - A grouping of kinds of soil into special units, sub-classes, and classes according to their capability for intensive use and the treatments required for sustained use, prepared by the Soil Conservation Service, USDA.

LAND FORM - Any physical, recognizable form or feature of the earth's surface, having a characteristic shape, and produced by natural causes such as flood plains, terraces, mountain buttes, etc.

LAND RESOURCE AREAS - An area of land reasonably alike in its relationship to agriculture with emphasis on combinations and/or intensities of problems in soil and water conservation.

LAND RIGHTS COST - Expenditures for acquiring land or easements, relocation of existing utilities and public property and associated legal costs.

LAND SUITABLE FOR TIMBER PRODUCTION - This includes all land capable of producing crops of commercial wood (20 cubic feet or more per acre annual growth capability). Present land uses, such as transportation and utilities, wilderness, and recreation were not excluded from this total acreage.

LAND TREATMENT MEASURES - A tillage practice, a pattern of tillage or land use, or land or management facility improvements to alter runoff, reduce sediment production, improve use of drainage and irrigation facilities, or improve plant or animal production.

MAN YEAR - One person employed for one year.

MANAGEMENT MEASURES - Those measures applied in the form of decisions by the land user without the application of installation of practices.

MEAN ANNUAL RUNOFF - The average value of all annual runoff amounts usually estimated from the period of record or during a specified base period from a specified area. See BASE PERIOD AND RUNOFF.

METAMORPHIC ROCK - Any rock derived from pre-existing rocks by mineralogical, chemical and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in the earth's crust.

MINERAL RESOURCES - All commercial items related to geology. Includes mining, sand and gravel, limestone for cement, ornamental or construction stones, saline playa products, petroleum, and geothermal products.

MILLIGRAMS PER LITER - The weight in milligrams of any substance contained in one liter of liquid. Nearly the same as parts per million.

MILLION GALLONS PER DAY - A statistical term relating to water use.

MINIMUM TILLAGE - That amount of tillage required to create the proper soil condition for seed germination and plant establishment.

MITIGATION - Providing of services or facilities to compensate for project induced environmental detriments.

MULTIPLE USE - The management of all the various renewable surface resources so that they are utilized in the combination that will best meet the needs of society, without impairment to the productivity of the land, and with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

MULTI-PURPOSE PROJECT - A project designed to serve more than one purpose; for example, irrigation, flood control, recreation, and hydroelectric power.

MUNICIPAL AND INDUSTRIAL WATER - Water supplied to a central municipal distribution system, for rural domestic use, stock water, steam electric powerplants, and water used in industry and commerce.

NATIONAL ECONOMIC DEVELOPMENT - One of the accounts used in the Four-Account System of economic and environmental evaluation. It displays benefits and costs from the national viewpoint.

NATURAL AREAS - Areas set aside by federal, state, county, and private organizations to preserve permanently, in unmodified condition, representative environments for the purposes of science, research, and/or education. Developed recreation sites do not exist within these areas.

NATURAL FLOW - The rate of water movement past a specified point on a natural stream from a drainage area for which there have been no effects caused by stream diversion, storage, import, export, return flow, or change in consumptive use caused by man-controlled modifications to land use. Natural flow rarely occurs in a developed country.

NET RESERVOIR EVAPORATION - The difference between the total evaporation from the reservoir water surface and the evapotranspiration from the reservoir area under prereservoir conditions, with identical precipitation considered for both conditions.

NET WATER YIELD - The available water runoff at a given location, both surface and subsurface, after the upstream uses by man's activities, use by phreatophytes, and evaporation from upstream free water surfaces.

NON-COMMERCIAL FOREST LAND - Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions, and productive forest land withdrawn from commercial timber use through statute or administrative regulations.

NON-IRRIGATED CROPLAND - Those non-irrigated cultivated lands that are used for the production of grain crops (harvested and/or grazed), orchard, and field crops.

NONSTOCKED AREAS - Commercial forest land less than 10 percent stocked with growing-stock trees. Generally brush and/or currently non-commercial tree species are present.

NORMAL - A mean or average value established from a series of observations for purposes of comparison, for example, normal precipitation, normal temperature, normal flow.

NORMALIZED PRICES - The long term trend of prices, that are expected to be in effect after adjustment for seasonal and cyclical fluctuation.

OBERS PROJECTIONS - Economic projections for water resources planning areas, developed by the Economic, Statistics and Cooperatives Service (Economic Research Service) for the Water Resources Council.

OUTDOOR RECREATION CARRYING CAPACITY - An expression of the optimum per acre annual visitation at recreation areas. Levels of development, physical conditions (soil, climate, vegetation, slope, etc.) and the quality and type of recreation experience are factors that were considered in evolving capacity estimates.

OUTDOOR RECREATION UNIT - A facility or group of complementary facilities normally in a camp, picnic site or park, designed to accommodate a family or other small groups.

pH (HYDROGEN ION CONCENTRATE) - Measure of acidity or alkalinity of water. Distilled water, which is neutral, has a ph value of 7; values above 7 indicate the presence of alkalies, while those below 7 indicate acids.

PHYSIOGRAPHIC PROVINCE - A region all parts of which are similar in geologic structure and climate and which has consequently had a unified geomorphic history; a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

PHREATOPHYTE - A water-loving plant that obtains its water supply from the zone of saturation, either directly or through the capillary fringe.

PITTING - The construction of pits or basins of suitable capacity and distribution to retain water and increase infiltration on rangeland.

PROJECT EVALUATION PERIOD - Expected useful life of project beginning at end of installation of project.

POLLUTION (WATER) - The alteration of the physical, chemical, or biological properties of water, or a discharge of any substance into water, which adversely affects any legitimate beneficial water use.

PARTS PER MILLION (PPM) - Parts in weight per million units of water.

PEAK FLOW - The maximum instantaneous discharge of a stream or river at given location.

PEAK LOAD (POWER) - The maximum load in a stated period of time. Usually it is the maximum integrated load over an interval of one hour which occurs during the year, month, week, or day. It is used interchangeably with peak demand.

RANGE - (1) All land producing native forage for animal consumption and land that is revegetated naturally or artifically to provide a forage cover that is managed like native vegetation. Generally considered as land that is not cultivated. (2) (Wildlife) the geographic area occupied by an animal or bird.

RANGE CONDITION - The current productivity of a range relative to what that range is naturally capable of producing.

RANGE CONDITION CLASS - One of a series of arbitrary categories used to classify range conditions, usually expressed as either excellent, good, fair, or poor.

RANGE CONDITION TREND - The direction of change in range condition.

RANGE MANAGEMENT - A distinct discipline founded on ecological principles and dealing with the husbandry of rangelands and range resources.

RANGE SEEDING - The process of establishing vegetation by the artificial dissemination of seeds.

RECREATION SUPPLY - Those recreation resources which are or will become available to fulfill recreation demand.

REST OF NATION (RON) - One of the parts used in the Four-Account System of project evaluation.

RETURN FLOW - That part of a diverted flow which is not consumptively used and which returns to a surface supply.

RIPARIAN LAND - Land situated along the bank of a stream or other body of water.

RIPARIAN RIGHTS - The rights of an owner whose land abuts water. They differ from state to state and often depend on whether the water is a river, lake, or ocean. See Water Rights.

RIPARIAN VEGETATION - Vegetation growing on the banks of a stream or other body of surface water.

RIVER BASIN DEVELOPMENT - A program to develop the use of the water and land resources of a river basin, so coordinated as to obtain a greater efficiency of use than would be possible if the resources were developed by uncoordinated multiple-purpose projects.

ROCKLAND - Areas containing shallow soils and rock outcrops occupying from 25 to 90 percent of the area. A miscellaneous land type.

ROTATION-DEFERRED GRAZING - Grazing under a system where one or more grazing units are rested (not grazed) at planned intervals. Deferment is based upon the growing season of key forage plants. Generally, no unit is grazed at the same time in successive years.

ROTATION GRAZING - Grazing two or more pastures or parts of a range in regular order, with definite recovery periods between grazing periods. Where only two fields are involved. Sometimes called alternate grazing. Contrast with continuous grazing.

RUNOFF (HYDRAULICS) - That portion of the precipitation on a drainage area that is discharged from the area in stream channels. Types include surface runoff, ground water runoff or seepage.

SEDIMENT CONTROL - The control of movement of sediment on the land, in a stream or into a reservoir by means of manmade structures; such as debris dams, wing dams, or channelization; land management techniques, or natural processes.

SEDIMENT LOAD - The total sediment, including bedload, being moved by flowing water in a stream at a specified cross section.

SEDIMENT YIELD - That amount of sediment transported by a stream system that may be measureable at a particular location. Usually expressed in acre-feet per square mile per year or tons per acre per year.

SEDIMENTARY ROCK - A rock resulting from the consolidation of loose sediment that has accumulated in layers; e.g. a clastic rock (such as conglomerate, eolianite, or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice, or a chemical rock (such as rock salt or gypsum) formed by precipitation from solution, or an organic rock (such as certain limestones) consisting of the remains or secretions of plants and animals.

SEDIMENTATION - The accumulation or depositing of fragments of material that settle from water or air. The material normally results from the erosion process.

SEMIARID - A term applied to regions or climates where moisture is normally greater than under arid conditions but still definitely limits the growth of most crops. Dryland farming methods or irrigation generally are required for crop production. The upper limit of average annual precipitation in the cool semiarid regions is as low as 15 inches. Whereas in tropical regions, it is as high as 45 or 50 inches. Contrast with arid.

SITE INDEX - (forestry) A numerical expression commonly accepted as an indicator of the quality or timber productivity of a site. It is an expression of the height-age relationship of the tallest trees (dominants and codominants) in normal stands at some designated age, such as 50 years.

SOCIAL WELL-BEING - One of the accounts used in the Four-Accounts System of economic and environmental evaluation procedure.

SODIUM ABSORPTION RATIO (SAR) - The ratio of sodium ions to the square root of half the calcium plus magnesium ions. The SAR predicts reasonably well the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High values of SAR imply a hazard of sodium replacing absorbed calcium and magnesium and this replacement is damaging to the soil structure.

SOIL ASSOCIATION - A group of defined and named soil series associated together in a characteristic geographic pattern but not necessarily similar pattern. Each soil association is named for the major soil series components it contains and differs from other soil associations by having contrasting soil properties or different potentialities.

SOIL RESOURCE GROUP - A broad grouping of soils that have similar cropping patterns, yield characteristics, responses to fertilizer, management, and land treatment measures.

STREAMFLOW - The rate of flow of water past a specified point in a stream channel. Streamflow can originate from either a natural or a modified environment.

STREAMFLOW DEPLETION - That amount of water lost from a stream between two given locations during a specified period of time.

STRIPCROPPING - Growing crops in a systematic arrangement of strips or bands which serve as barriers to wind and water erosion.

STUBBLE MULCHING - The stubble of crops or crop residues left essentially in place on the land as a surface cover during fallow and the growing of a succeeding crop.

STRUCTURAL MEASURE - Measures such as installation of dams, levees, channel improvements, etc.

SUB-ALPINE - A vegetation zone usually in mountains joining and below the alpine area or having a similar climate. It supports some trees in contrast to the alpine zone.

SUBHUMID - Regions or climates where moisture is normally less than under humid conditions but still sufficient for the production of many agricultural crops without irrigation or dryland farming. Natural vegetation is mostly tall grasses. Annual rainfall varies from 20 inches in cool regions to as much as 60 inches in hot areas. See HUMID.

SUSPENDED SEDIMENT - Sediment particles suspended in a liquid.

SUSPENDED SOLIDS - Solids which are not in true solution and which can be removed by filtration.

SUSTAINED YIELD - Achievement and maintenance, in perpetuity, of a certain annual or regular periodic output or harvest of the various renewable land and water resources.

TOTAL DISSOLVED SOLIDS (TDS) - A measure of the mineral constituents in a liquid, usually expressed as mg/l.

TRANSPIRATION - The process whereby free water in a plant is released as a vapor into the air through the leaves or bark.

TURBIDITY - The measure of the extent to which the intensity of light passing through water is reduced by the suspended matter.

URBAN LAND - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible. A miscellaneous land type.

URBAN POPULATION - The total number of people living in urban places and urbanized areas. In general, this includes all persons living in urbanized areas and in places of 2,500 inhabitants or more, outside of urbanized areas.

VALLEY FILL - Alluvium or other material occupying areas below mountain slopes.

VISITOR DAY - Twelve visitor hours of recreation use. (It may be composed of twelve persons visiting for one hour each, etc. A visitor hour is composed of one person visiting for 60 minutes, five persons for 12 minutes each, etc. One overnight 24-hour visit would consist of two visitor days.)

WATER BUDGET - An accounting of all inflow to, outflow from, and changes in storage within a hydrologic unit such as a drainage basin, soil zone, aquifer, lake, or project area.

WATER QUALITY - A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

WATER MANAGEMENT - The analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of man. Watershed management for water production is concerned with the quality, quantity, and timing of the water which is produced.

WATER REQUIREMENT - The total quantity of water, regardless of its source, required for a specified use under a predetermined or prescribed situation.

WATER REQUIREMENT (AGRICULTURAL) - The total quantity of water, regardless of its source, required for production of crops at their normal growth under field conditions. It includes applied water, subsurface irrigation, and precipitation needed by the crops.

WATER RIGHT - A legally protected right to take possession of water occuring in a water supply and to divert that water and put it to beneficial use.

WATER TABLE - The surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

WATER YEAR - A continuous 12-month period of time for which water records are compiled and summarized. In the Pacific Southwest, it starts October 1.

WATERSHED - All lands enclosed by a continuous hydrologic drainage divide and lying upslope from a specified point on a stream.

WATERSHED INVESTIGATION REPORT (WIR) - A report on a potential PL-566 Project.

WATERSHED MANAGEMENT - The analysis, protection, development, operation or maintenance of the land, vegetation and water resources of a drainage basin for the conservation of all its resources for the benefit of man. Watershed management for water production is concerned with the quality, quantity, and timing of the water which is produced.

WATERSHED PLANNING - Formulation of a plan to use and treat water and land resources.

WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS - A system of land treatment or soil conservation practices combined with structural measures installed to improve infiltration and reduce erosion of land within a drainage basin and to protect lands from floods.

WATERSPREADING - The application of water to lands for the purpose of increasing the growth of natural vegetation or to store it in the ground for subsequent withdrawal by pumps for irrigation.

WILDERNESS - Those areas classified by Congress or other authority as a wilderness or primitive area.

WILDFIRE - Natural or man-caused fires burning on forest, brush, or grass-covered lands, not confined to safe and predetermined control lines or set for a legal purpose, and on which fire control action is necessary to prevent resource and watershed damage.

WILDLIFE LAND - Land managed or used primarily for wildlife.

WILDLIFE MANAGEMENT - The art of producing sustained annual crops of wildlife.

WILDLIFE MANAGEMENT AREA - Delineated area of land for wildlife management.

WITH PLAN CONDITION - The conditions estimated to hold true if a contemplated project or program is implemented.

WITHOUT PLAN CONDITION - The conditions estimated to prevail if all ongoing programs remain at their current levels of activity.

WOODLAND - Any land used primarily for growing trees and shrubs. Woodland includes, in addition to what is ordinarily termed "forest" or "forest plantations," shelterbelts, windbreaks, wide hedgerows, containing woodland species for wildlife food or cover, stream and other banks with woodland cover, etc. It also includes farmland and other lands on which woody vegetation is to be established and maintained.

APPENDIX B

HYDROLOGY

APPENDIX B. HYDROLOGY

S U R F A C E   W A T E R   S U P P L Y

A study of a number of stream gaging stations were analyzed to determine the monthly distribution of water yield.

Tributaries to the Canadian River above Conchas Reservoir, Ute Creek, and the Dry Cimmarron were selected for study. Two stations on the Canadian River proper were also studied.

Tributaries to the Canadian River above Conchas Reservoir all have similar flow patterns. April and May are the big runoff months, with another peak, not quite as large, in August. The April and May runoff is due to the spring snow melt, and the August peak is produced by summer rainstorms.

The areas away from the influence of the mountains have a definite peak volume of runoff in August which is caused by summer rainstorms.

The Dry Cimmaron, though mountains are the northern boundary, has no indication of April and May snow melt. There is some indication of sizeable runoff in June and July, but the big runoff occurs in August.

The Canadian River near Sanchez indicates that the peak runoff period above that point is in August, although the runoff in April and May is almost as large.

At this gaging station, about 156,500 acre-feet is discharged annually. If the annual surface water use for Colfax (54,200 acre-feet), Mora (23,400 acre-feet), and Harding (2100 acre-feet) Counties are added to that, the yield is 236,200 acre-feet, or 0.74 inches.

Yields from other drainages are as follows: Conchas River about 12,390 acre-feet (0.44 inches), the Ute Creek about 19,780 acre-feet (0.26 inches), and the Dry Cimmarron about 18,760 acre-feet +6,180 (depletions) or 24,940 acre-feet, 0.45 inches. These yield values check closely with the "Average Annual Water Yield" Map made up by the SCS in 1954 and updated in 1972, map no. M7-0-22432D.

There has been some question about the validity of the yield map, and this substantiates its accuracy for estimating purposes in the AWR. The accuracy has been proven on the Rio Grande above the Elephant Butte Reservoir.

TABLE APPENDIX B-1

RESERVOIRS AND LAKES UNDER 40 SURFACE ACRES IN
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Name	Location Twp.	Rge.	Sec.	Surface Area - Acres Maximum	Average	Use
Colfax County						
Armstrong Lake	31N.	26E		5	4	-
Cimarroncito Res.	26N.	18E.	17	7	7	WS
Cimarron Res.	27N.	17E.		20	15	WS
Industrial School	25N.	22E.		10	9	WS
Merrick Lake	31N.	17E.		24	20	R
Munn Lake	31N.	17E.		37	32	R
Bernal Lake	31N.	17E.		11	11	R
Springer City Res.	25N.	22E.		22	15	WS
Lewis Res.	26N.	19E.	23	30	15	-
Juaquilla Res.	25N.	27E.		12	10	-
Armstrong Res.	30N.	24E.		4	3	I
Crews Res.	28N.	23E.		6	6	S
Springer Arroyos Res.	26N.	23E.	36	9	9	S
Sauble Arroyo Res.	26N.	24E.	4	8	8	S
Chico Springs Res.	24N.	25E.	14	6	5	I
Tom Jack Res.	24N.	27E.		3	3	I
Urraca Res.	25N.	18E.	2	9	9	I
Ute Creek Res.	27N.	17E.	10	1	1	-
Van Burggen Res.	27N.	21E.	25	5	4	-
Kitrell Res.	27N.	24E.	20.30.	10	5	-
Hagadorn Res. (Res. No. 5)	29N.	19E.	16	27	25	I
Lake Alice	31N.	24E.	4	6	2	WS
Chico	24N.	23E.		6	5	I

Note: Use Symbols are: FC - Flood Control; I - Irrigation; P - Power; R - Recreation; WS - Municipal or Industrial Water Supply; - not determined.

Source: New Mexico SEO, Revised July 1972.

TABLE APPENDIX B-1 (Contd.)

RESERVOIRS AND LAKES UNDER 40 SURFACE ACRES IN
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Name	Location Twp.	Rge.	Sec.	Surface Area - Acres Maximum	Average	Use
Colfax County (Contd.)						
C. S. Ranch	25N.	20E.	1	9	3	I
Brown Res.	26N.	24E.	29	19	15	-
Soden	27N.	17E.	10	1	1	-
Monte Verde (Lebus)	25N.	15E.	36	36	26	-
Jaritas Res.	23N.	24E.	4	8	4	-
Colfax County, Total Surface Acres (Average)				351	272	
Harding County						
Abbott Lakes	23N.	24E.	25	36	20	I
Carros Res.	15N.	30E.	23, 26	3	3	-
Wind	15N.	30E.	28	3	1	S
Dog	15N.	30E.	16	5	2	S
Stapp No. 1	14N.	30E.	26	2	1	S
Stapp No. 2	14N.	31E.	5	4	2	S
Harding County, Total Surface Acres (Average)				53	29	
Mora County						
Berlier Pos.	21N.	21E.	28	9	9	I
Calley Lake	20N.	20E.	33	30	20	I
Encantado (Enchanted)	20N.	14E.	17	3	3	-
Laguna Linda	20N.	14E.		10	10	-
Middle Fork Lake	21N.	13E.	35	7	7	R
Mossman Res.	20N.	20E.		30	10	I
Murphy (Morphy)	20N.	15E.	30	32	25	I

TABLE APPENDIX B-1 (Contd.)

RESERVOIRS AND LAKES UNDER 40 SURFACE ACRES IN
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Name	Location Twp.	Rge.	Sec.	Surface Area - Acres Maximum	Average	Use
Mora County (Contd.)						
Pacheco Lake	20N.	14E.	8	5	5	R
Riner Lake	20N.	16E.		20	15	-
North Fork Lake	20N.	14E.		2	2	R
Arroyo del Ancho (Rancho)	19N.	22E.		3	3	I
Washburn & Buck	20N.	22E.	33	2	2	-
Shufelt	20N.	16E.	21	8	8	-
Hunker's (Collins) Lake	20N.	15E.		11	11	-
Schiele	23N.	18E.		10	10	-
Watrous Farms (Phoenix)	18N.	18E.		39	30	-
Lujan Res.	23N.	15E.	12	3	3	-
Laguna Salina	19N.	17E.		5	3	-
Fernandez Lake	23N.	21E.		6	3	-
Mora County, Subtotal Surface Acres (Average)				235	179	
Quay County						
Hiton Creek Res.	11N.	35E.	31	25	15	I
Quay County, Total Surface Acres (Average)				25	15	

TABLE APPENDIX B-1 (Contd.)

RESERVOIRS AND LAKES UNDER 40 SURFACE ACRES IN
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Name	Location Twp.	Rge.	Sec.	Surface Area - Acres Maximum	Average	Use
San Miguel County						
Maestas Lake	19N.	14E.		3	3	R
Sink Hole Gap Res.	13N.	30E.	8	12	10	-
Ryner's Lake	17N.	24E.		20	15	I
San Miguel County, Subtotal Surface Acres (Average)				35	28	
Union County						
Gardner Res.	23N.	32E.	5	16	10	I
Snyder Lake	25N.	31E.	2,11	20	15	I
Brown Lake	32N.	30E.	30	19	15	I
Atchley (5) 5 Lakes	22N.	31E.	23	54	35	I
Smithson (4) 4 Lakes	22N.	31E.	29	59	39	I
Ewing	29N.	30E.	34	1	1	I
Selby	28N.	34E.	32	7	3	S
Eklund	26N.	35E.	23	3	1	S
Garrett	26N.	28E.	26	18	9	I,S
Union County, Total Surface Acres (Average)				197	128	
AWR BASIN, TOTAL SURFACE ACRES (AVERAGE)				896	651	

Source: New Mexico SEO, 1972

TABLE B-2 - RESERVOIRS AND LAKES IN ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO WITH 40 OR MORE SURFACE ACRES

Name and Stream	Location 1/ Twp.	Rg.	Sec.	Elevation	Surface Area (Acres) Maximum 2/	Average	Use	Administrative Agency
Colfax County								
Throttle Reservoir-Una del Gato Creek	30N.	25E.	13	6,738 3/	150	120	I	T. O. Ranch Company
Miami Lake No. 2 - Rayado	24N.	19E.	2	6,386**	212	140	I,R	Miami Water Users Assoc.
Bartlett Lake-Leandro Creek	31N.	17E.	23	8,690 II	120	120	R	W. S. Ranch Company
Adams Lake-Leandro Creek	31N.	17E.	22	8,690 II	73	70	R	W. S. Ranch Company
Mary's Lake-Van Bremmer Canyon	30N.	17E.	29	8,246**	115	115	R	W. S. Ranch Company
Eagle Nest Lake-Cimarron River	27N.	16E.	34	8,198**	2,426	990	I,R,WS	Charles Springer Cattle Co.
Springer Lake-Cimarron River 5/	25N.	22E.	17	5,933**	391	270	I	Springer Ditch Company
Antelope Valley No. 2 5/ Reservoir-Cimarron River	26N.	20E.	11	6,232**	430	280	I	Antelope Valley Irr. Dist.
Antelope Valley No. 3 5/ Reservoir-Cimarron River	26N.	21E.	28	6,126*	119	80	I	Antelope Valley Irr. Dist.
French Lake-Cimarron River 5/	26N.	19E.	35	6,380**	72	50	I	W. S. Ranch Company
Websters Lake-Cimarroncito	26N.	18E.	14	7,045**	42	30	WS	Boy Scouts of America
Jaritas Reservoirs No. 1 & 2-Jaritas Arroyo	24N.	24E.	13	6,005*	300	200	I	Private
Rito del Plano Reservoir-Rio del Plano	26N.	24E.	21	6,125	77	50	I	Sauble Ranch Company

TABLE B-2 (Contd.) - RESERVOIRS AND LAKES IN ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO WITH 40 OR MORE SURFACE ACRES

Name and Stream	Location 1/ Twp. Rg. Sec.	Elevation	Surface Area (Acres) Maximum 2/	Average	Use	Administrative Agency
Colfax County (Contd.)						
Lake Maloya-Chico Rico Creek	32N. 24E. 27	7,511 3/	114	70	R, WS	City of Raton
Maxwell No. 2 Reservoir- 5/ Canadian & Vermejo Rivers	27N. 22E. 6	6,148 3/	420	300	FC,I,R	Vermejo Conservancy Dist.
Maxwell No. 11 Reservoir- 5/ Canadian	27N. 22E. 16	6,047 3/	126	120	FC,I,R	Vermejo Conservancy Dist.
Maxwell No. 12 Reservoir- 5/ Canadian & Vermejo Rivers	26N. 22E. 22	6,066 3/	335	210	FC,I,R	Vermejo Conservancy Dist.
Maxwell No. 13 Reservoir- 5/ Canadian & Vermejo Rivers	27N. 22E. 15	6,047 3/	336	220	FC,I,R	Vermejo Conservancy Dist.
Maxwell No. 14 Reservoir- 5/ Canadian & Vermejo Rivers	27N. 22E. 11	6,048	170	70	FC,I,R	Vermejo Conservancy Dist.
Stubblefield Reservoir- 5/ Canadian & Vermejo Rivers	27N. 21E. 13	6,133	1,150	560	FC,I,R	Vermejo Conservancy Dist.
Black Lake-Coyote Creek 6/	24N. 16E. 32	8,528**	70	70	R	Private
Colfax County, Total Surface Acres (Average)		11	7,248	4,135		
Harding County						
Lake-Tequesquite 5/6/	21N. 26E. 11	5,850	40	40	R	Private (State G & F)
Black Lake-Mosquero Creek 5/6/	19N. 28E. 24	5,300**	200	130	I	Private (State G & F)
Harding County, Total Surface Acres (Average)			240	170		

TABLE B-2 (Contd.) - RESERVOIRS AND LAKES IN ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO WITH 40 OR MORE SURFACE ACRES

Name and Stream	Location 1/ Twp. Rg. Sec.	Elevation	Surface Area (Acres) Maximum 2/	Average	Use	Administrative Agency
Mora County						
Charette Lake No.2-Ocate Creek 5/6/	23. 20E. 33	6,685**	108	108	R	G & F
Charette Lake No.3-Ocate Creek 5/6/	23N. 20E. 34	6,645**	321	321	R	G & F
Wagon Mound Salt Lake- 5/6/ Piedra Lumbre Arroyo	21N. 21E. 21	6,150**	200	130	R	G & F
La Cueva & Red Lake-Mora River 5/	20N. 16E. 21	7,008**	516	340	I	William Salmon
Horse Lake-Red Lake-Mora River 5/	20N. 16E. 22	6,985*	86	60	I	William Salmon
Cherry Valley (Leatherwood) 5/ Reservoir-Mora River	18N. 20E. 17	6,222*	100	60	I	Private
Laguna Yeso Reservoir- 5/ Sweet Water Creek	23N. 19E. 12	6,280**	80	50	I	Private
Mora County, Total Surface Acres (Average)			1,411	1,069		
Quay County						
Tucumcari Lake-Pajarito Creek 5/6/	11N. 31E. 18	4,008**	455	455	R	Quay County
Lake-Canadian River 5/6/	12N. 33E. 7	3,974*	90	90	R	Private
Ute Reservoir-Canadian River	13N. 33E. 21	3,760*	4,130	3,850	R,WS	ISC
Quay County, Total Surface Acres (Average)			4,675	4,395		

TABLE B-2 (Contd.) - RESERVOIRS AND LAKES IN ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO WITH 40 OR MORE SURFACE ACRES

Name and Stream	Location 1/ Twp. Rg. Sec.	Elevation	Surface Area (Acres) Maximum 2/	Average	Use	Administrative Agency
San Miguel County						
Lake David-Sapello River 5/	18N. 17E. 21	6,745**	229	150	I	E. F. Shellaberger
Lake Isabel-Sapello River 5/	18N. 17E. 21	6,756**	817	530	I	E. F. Shellaberger
Conchas Lake-Canadian River	14N. 26E. 28	4,201**	9,797	7,830	FC,I,R	CE
San Miguel County, Subtotal Surface Acres(Average)			10,843	8,510		
Union County						
Clayton Lake-Cieneguilla Creek	27N. 34E. 15	5,178	175	140	R	G & F
Weatherly Lake-Corrumpa Creek	29N. 31E. 30	6,100	92	60	I	Private
Pasamonte Lake-Tramperos Creek	24N. 30E. 27	5,700**	50	30	I	Private
Union County, Total Surface Acres (Average)			317	230		
ARKANSAS-WHITE-RED RIVER BASIN, TOTAL SURFACE ACRES (AVERAGE)			24,734	18,509		

Source: New Mexico SEO, Revised July 1972

Legend for Table B-1 and B-2
RESERVOIRS AND LAKES IN NEW MEXICO WITH 40 OR MORE
SURFACE ACRES -- DEFINITIONS AND SYMBOLS

1/ Indicates the location of the outlet works for man-made reservoirs and the main body of water for natural lakes.

2/ Surface area at spillway elevation or maximum when full for natural lakes.

3/ Data given in U. S. Bureau of Reclamation Safety of Dams Report.

4/ Data given in State Engineer Water Rights files.

5/ Off-Channel Reservoir

6/ Natural Lake

* Estimated from USGS quads, or other topo maps.

** Given on USGS quads.

Use:	Symbol
Irrigation	I
Power	P
Flood Control	FC
Water supply, municipal or industrial	WS
Recreation	R
Not Determined	-

Agency abbreviations: New Mexico Game and Fish Department--G & F; New Mexico Interstate Stream Commission--ISC; U. S. Bureau of Reclamation--USBR; Bureau of Sport Fisheries and Wildlife--F & WL; Bureau of Indian Affairs--BIA; Soil Conservation Service--SCS; and Corps of Engineers--CE.

Source: New Mexico SEO 1972

PEAK FREQUENCY ANALYSIS

Peak frequency analyses were run on records from selected stream gaging stations. Stream gage records which were analyzed are located on the Canadian River and its tributaries, the Dry Cimarron River, and the Tramperos Creek.

Frequency analyses were run by the Log Pearson Type III Method by the SCS ADP Center at the Central Technical Unit. All flow data were analyzed for several time periods. Time periods that were selected are: total length of records; 1940-1972; 1942-1972; 1950-1972, and 1964-1968. These time periods were selected in an effort to include all periods of continuous stream gage records and in an attempt to determine effect of different time periods on the frequency analysis.

Frequency curves for each gaging station were plotted on logarithmic probability paper. A regional analysis was made by comparing curves and plotting peaks for selected frequencies versus drainage area.

It appears from this analysis that na envelope with a wide range of peak flows can be used in the AWR Region if the condition of the watershed is known. The slopes of the curves seem to be about the same, but peaks are separated by several thousand cubic feet per second. The curves represent the slope of the frequency curves.

There are some stations that seem to fit the upper curve, but the majority of them seem to fit the lower curve very well. As is pointed out in the above reference, the two stations which are high may be and probably are high outliers for this sample. Two of the station records, with the high peaks, have a 20-year or less period of record. Records at both of these stations began in the early 50's and go through 1972.

In most periods of record there have been storms which statistically are outliers, either high or low. Outliers have been discarded for this analysis; however, frequency analyses have been preformed on data including all storms on record. The outliers were determined by procedures outlined in "Elements For Detecting Outliers in Samples from a Known Cumulative Probability Distribution", by W. H. Sammons, USDA, SCS, September 1976.

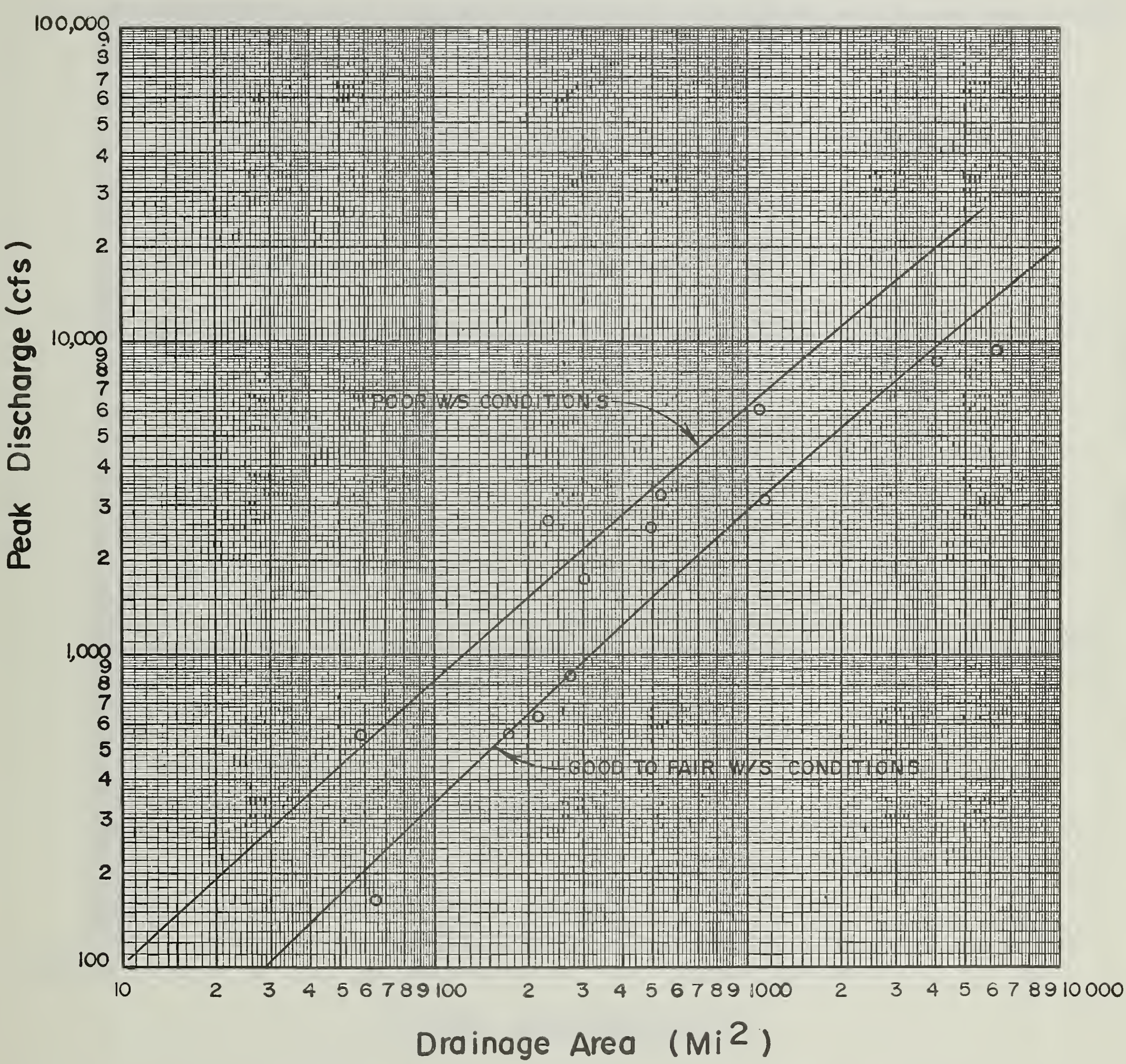
With knowledge of the hydrologic characteristics of a watershed in the AWR, these curves can be used to determine peak discharges for watersheds with drainage areas which exceed 30 square miles. Peak discharge for watersheds with 30 or less square mile drainage areas should be checked with these curves.

In all cases, the outliers were high and the deletion of the high outliers pulls the one-percent-chance peak down by several thousand c.f.s. Numbers of outliers varied from zero up to two. The 1965 event was determined to be a high outlier, in most cases, on the Canadian River. Other events which were determined high outliers were 1952, 1941, and 1942. The 1958 event on the Mora River was a high outlier.

For the periods of records which were analyzed it appears that the 1940-1972 and the 1950-1972 curves for most stations coincide very closely. The longer records tend to flatten the slopes, which increases the infrequent peaks and decreases the frequent events. Most of the curves without any outliers taken out coincide fairly closely.

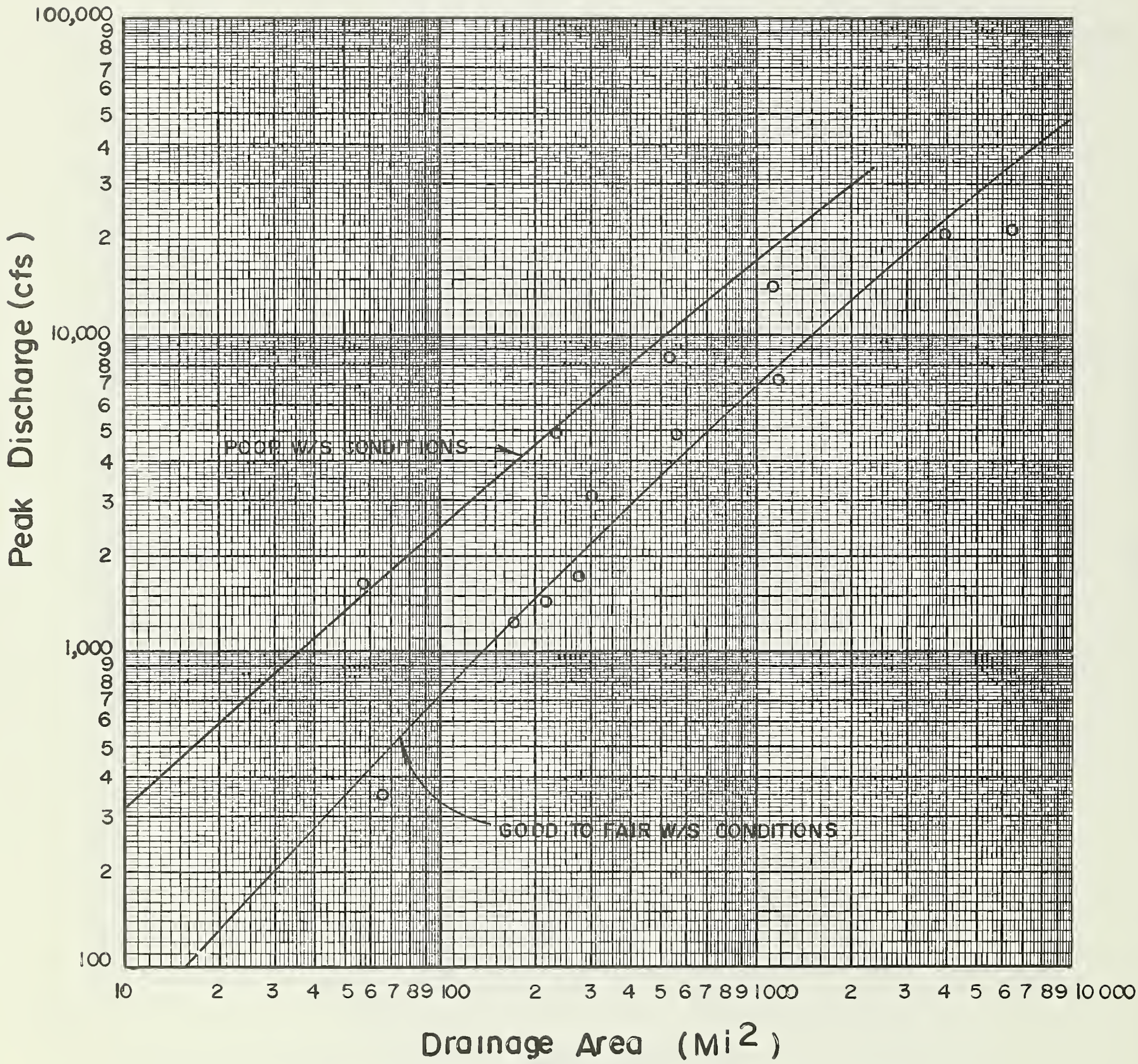
The 1964-1968 period is obviously too short a period of record to base a frequency analysis. In almost all cases, this short period of record, without any outliers deleted, produces higher peak discharges than the longer periods. All flow data is taken from USGS Water Supply Papers.

Fig. 1



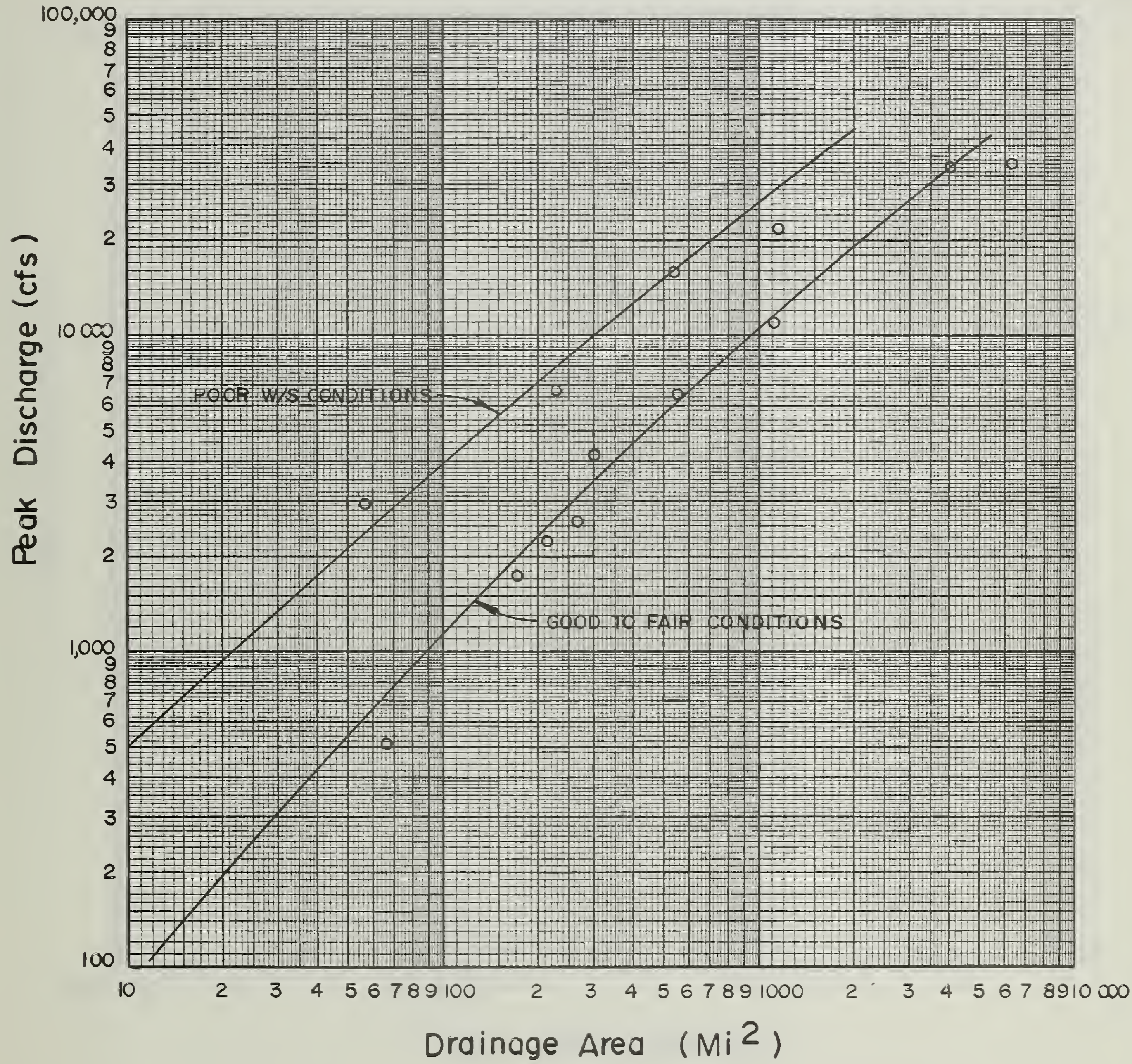
Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
2 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 2



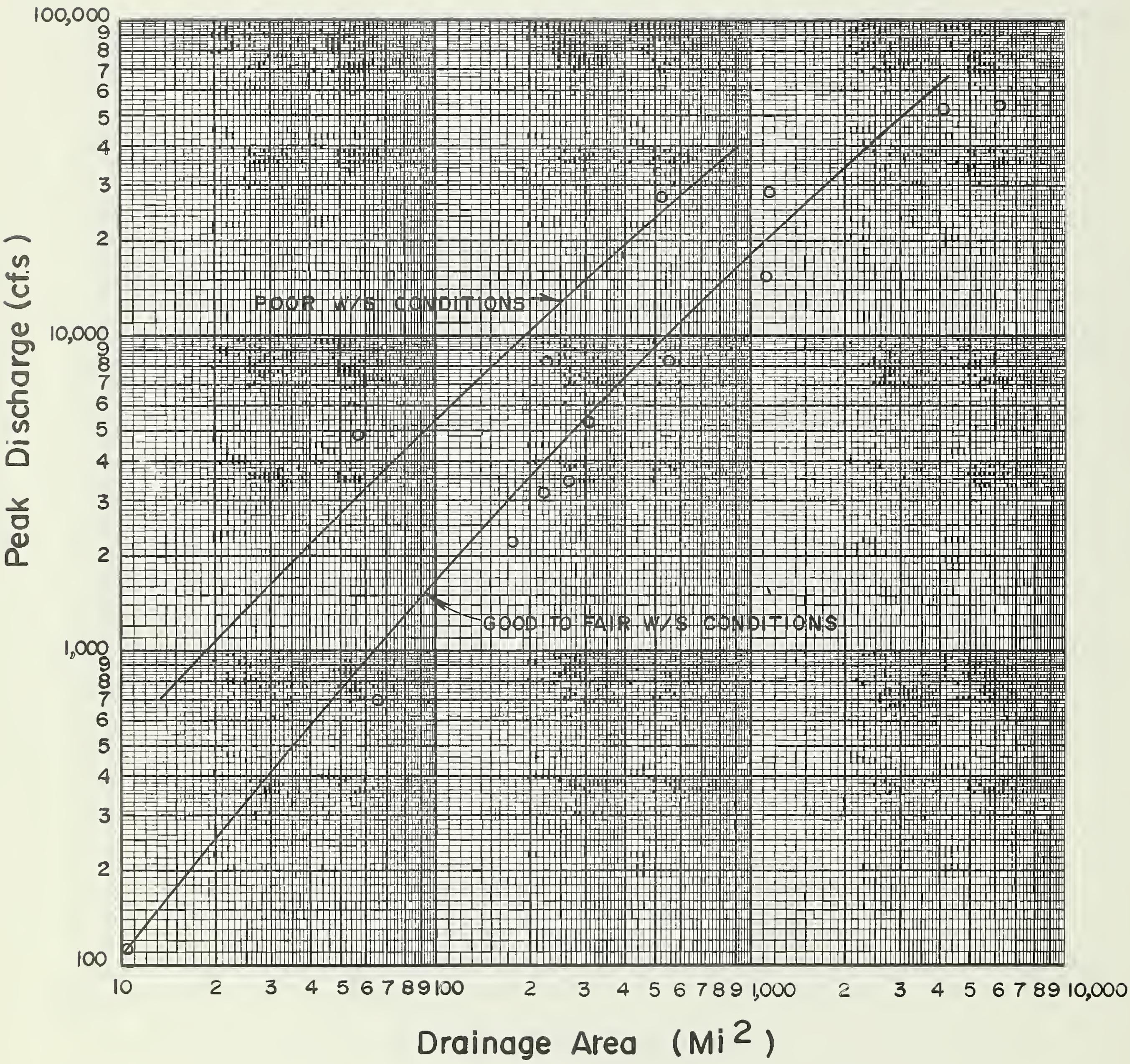
Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
5 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 3



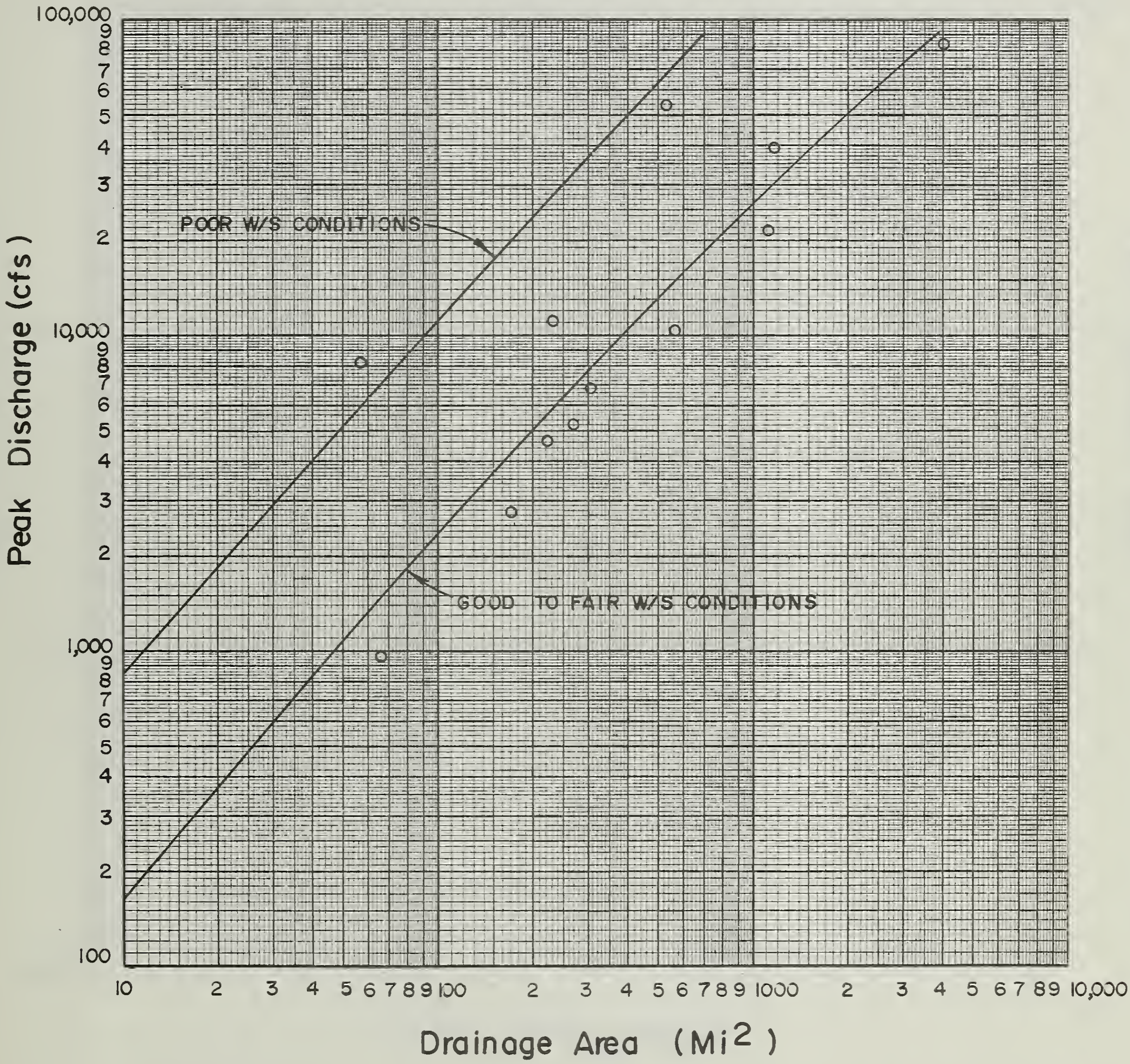
Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
10 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 4



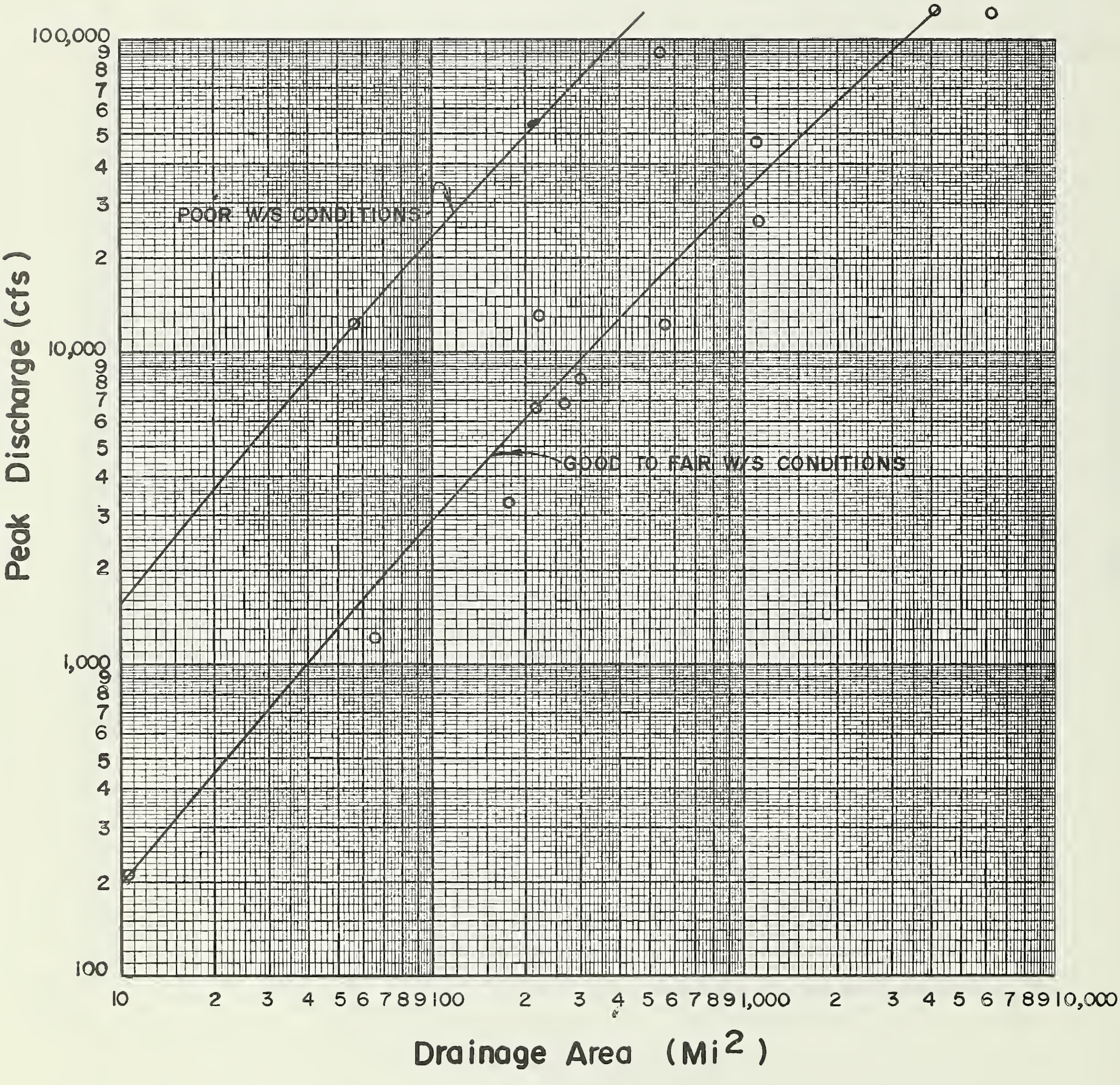
Log Pearson Type III Frequency Analysis
ArKansas White Red River Basin Regional Curves
20 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 5



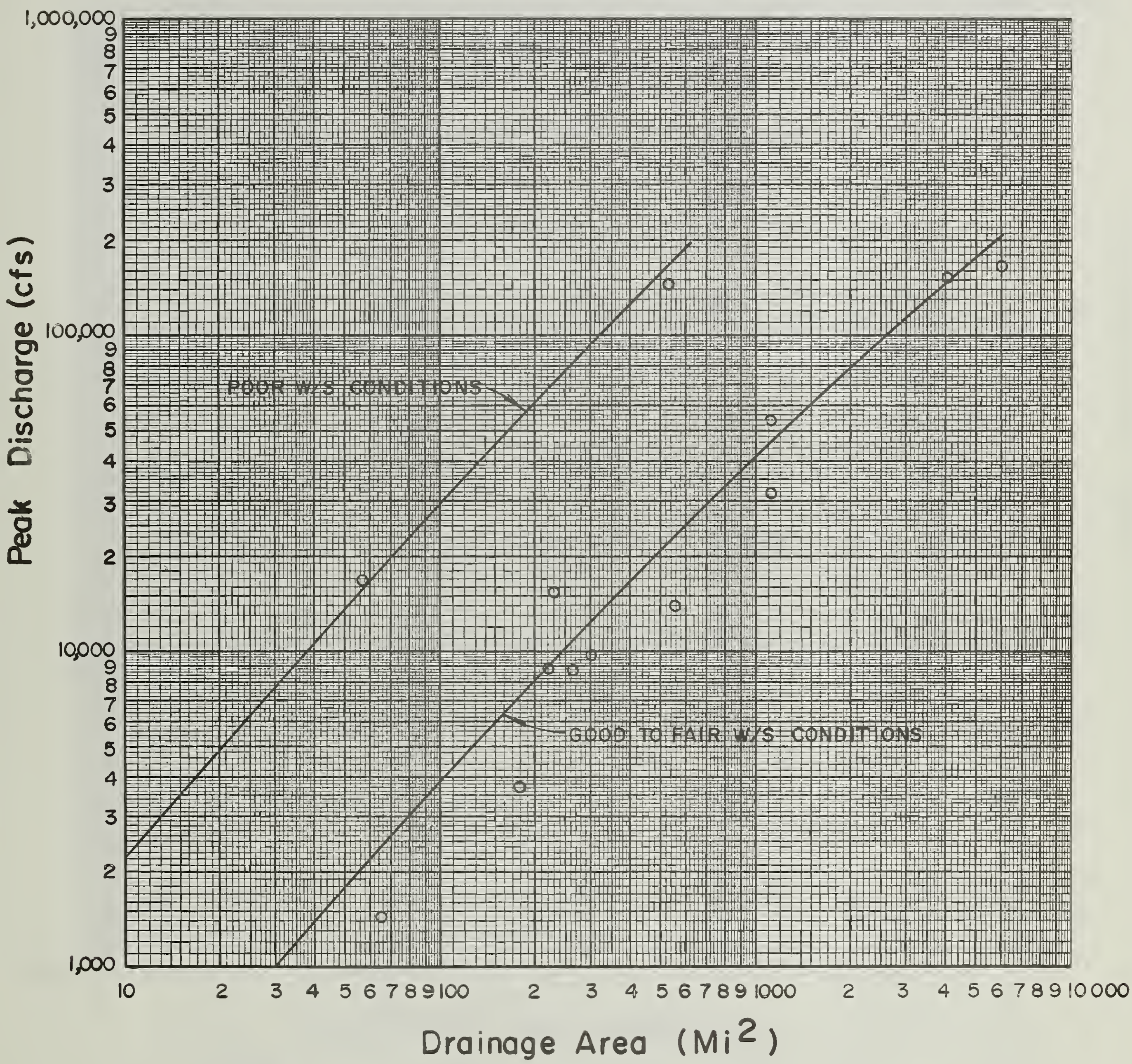
Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
50 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 6



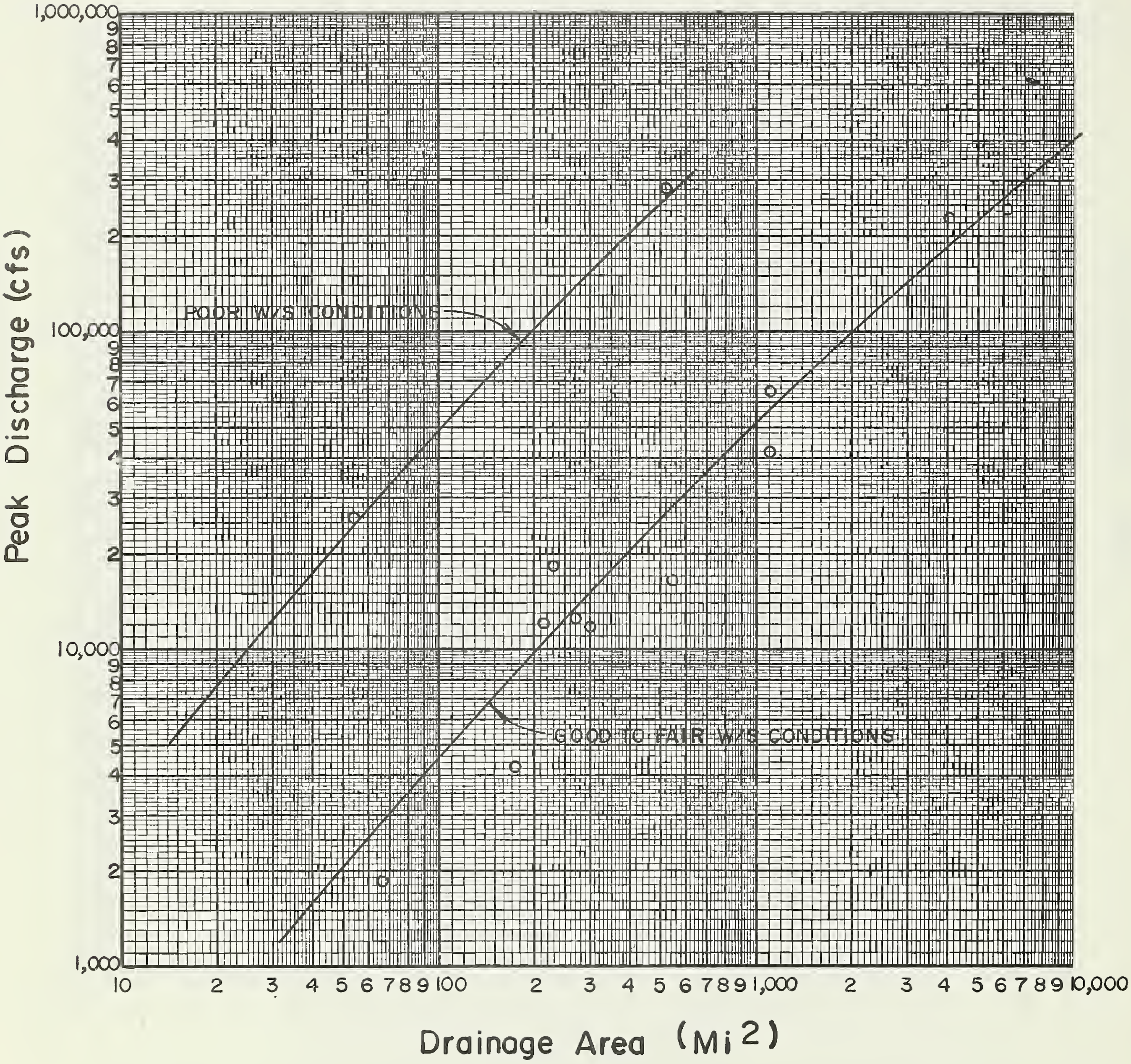
Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
100 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

Fig. 7



Log Pearson Type III Frequency Analysis
Arkansas White Red River Basin Regional Curves
200 Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

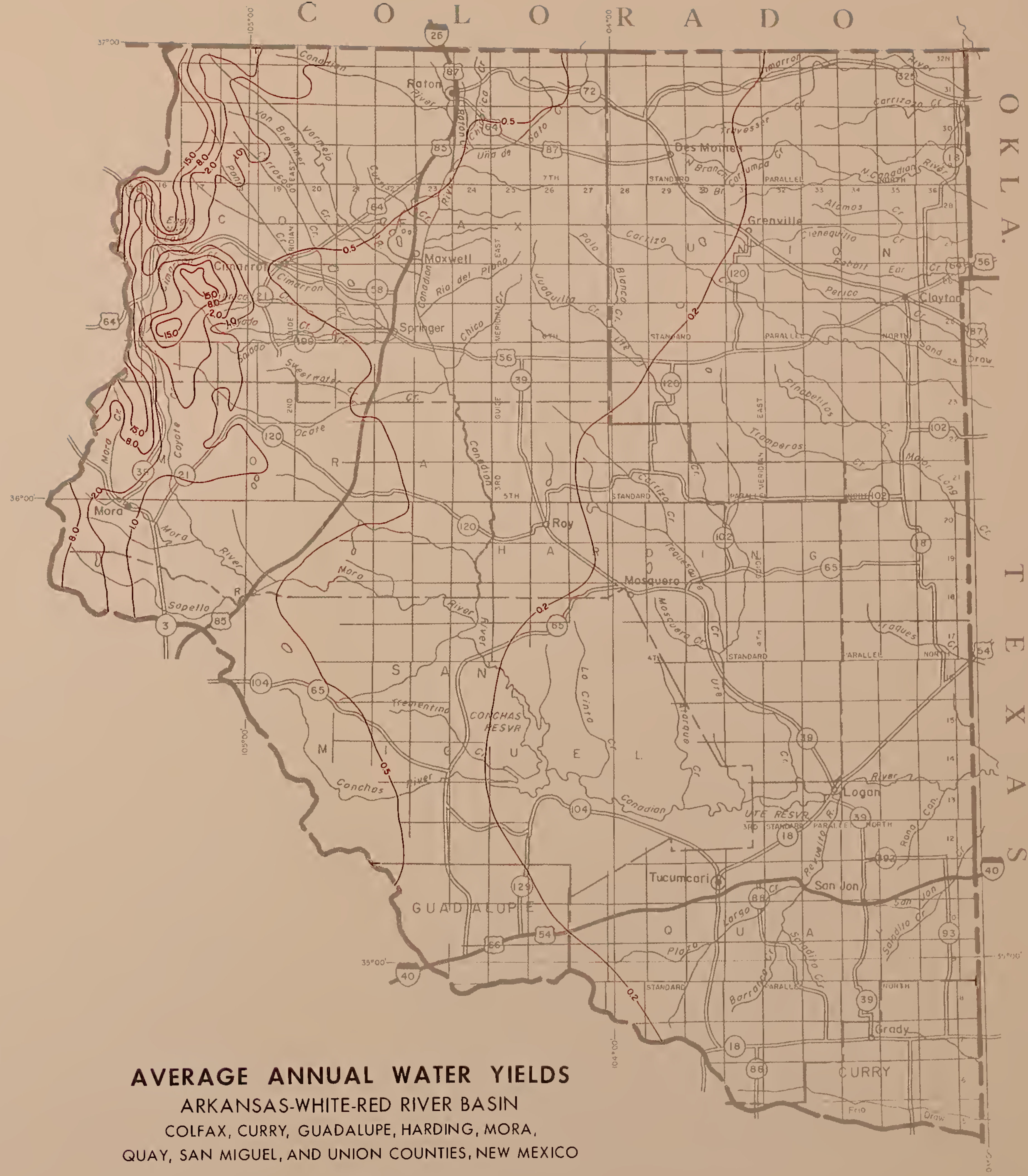
Fig. 8

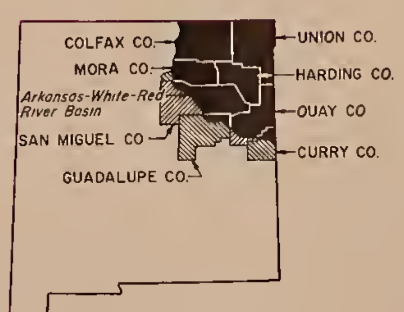


Log-Pearson Type III Frequency Analysis
Arkansas-White-Red River Basin Regional Curves
500-Year Frequency of Occurrence
Records Thru 1972 (Outliers Deleted)
SCS 1976

AVERAGE ANNUAL WATER YIELDS

Lines of Equal Water Yield in Inches





LOCATION MAP

AVERAGE ANNUAL WATER YIELDS

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

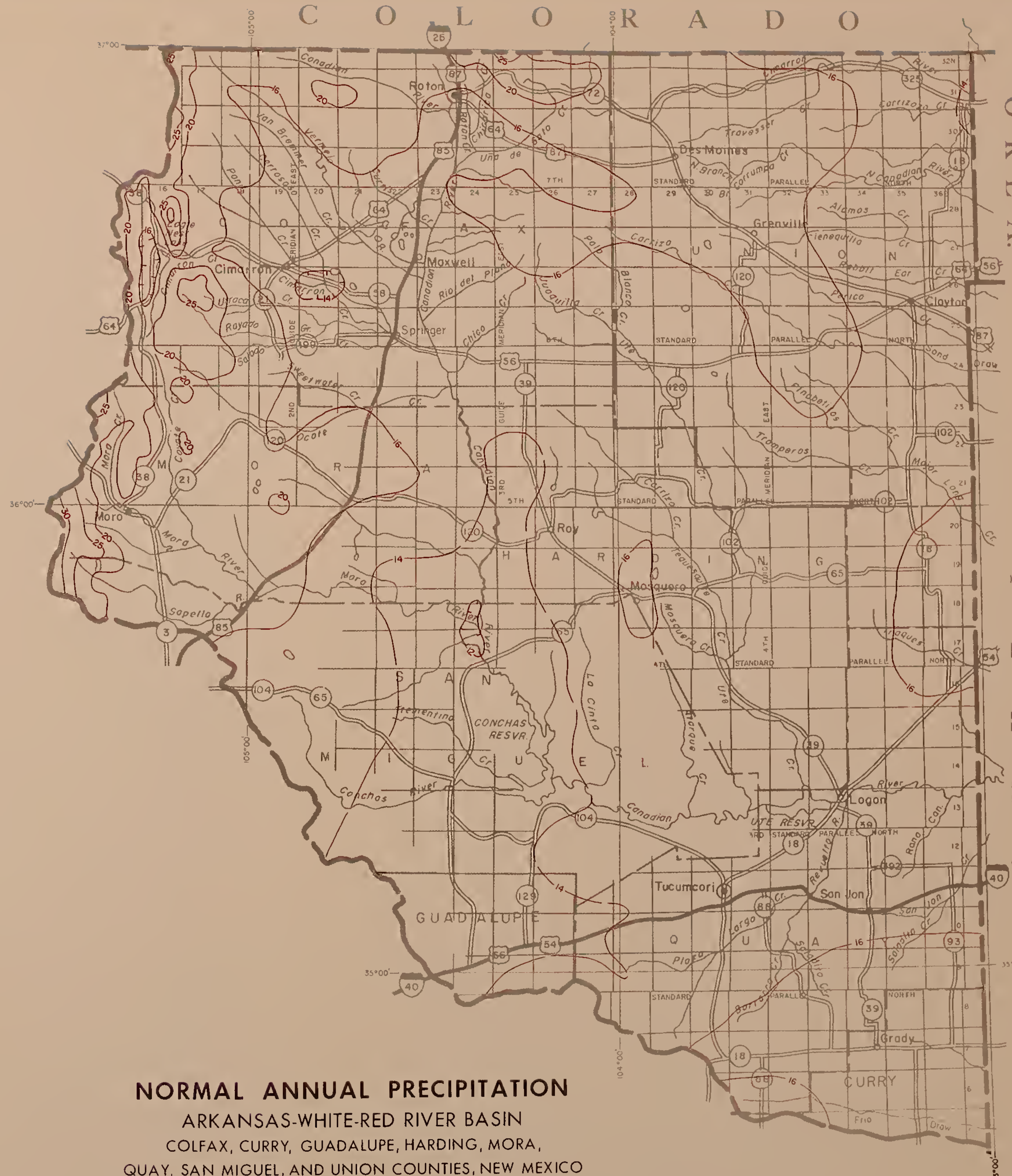
SCALE 1:1,200,000

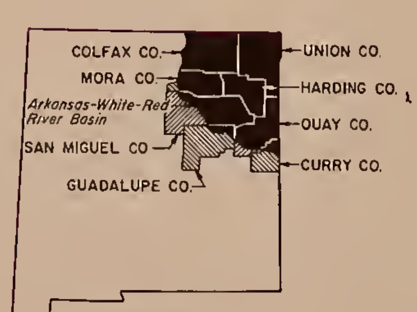
Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-9

NORMAL ANNUAL PRECIPITATION

- Lines of Equal Precipitation in Inches
- Lines of Equal Precipitation in Inches Decreasing Toward Direction of Ticks
- Interpolated Lines of Equal Precipitation (Period of Record 1931-1960)





LOCATION MAP

NORMAL ANNUAL PRECIPITATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

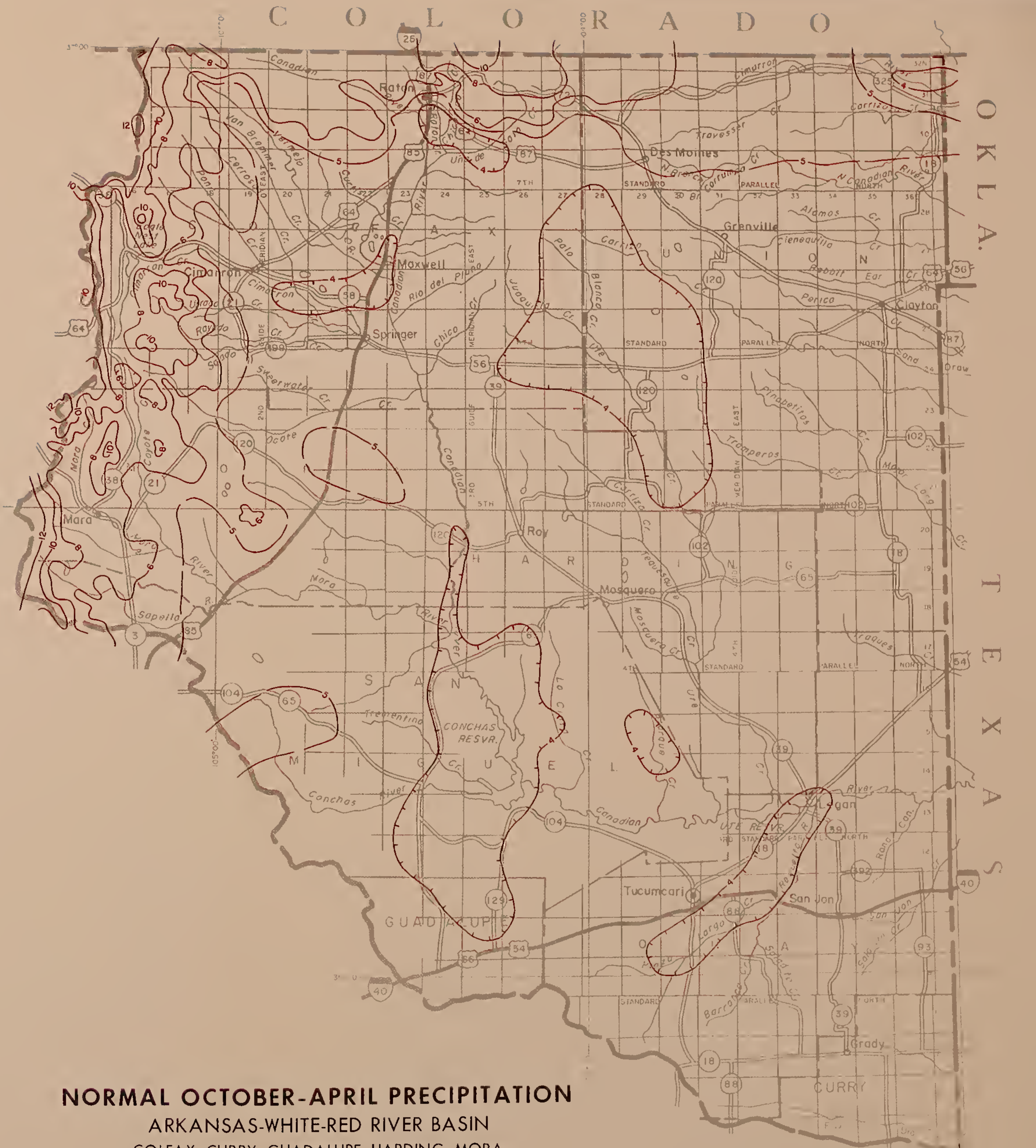
JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-8



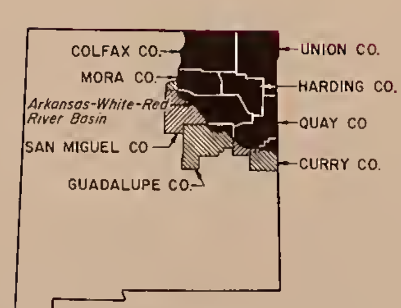
PRECIPITATION

Lines of Equal Precipitation in Inches

Lines of Equal Precipitation in Inches Decreasing Toward Direction of Ticks

Interpolated Lines of Equal Precipitation

Period of Record 1931-1960.



LOCATION MAP

NORMAL OCTOBER-APRIL PRECIPITATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

Source:
Base map prepared by SCS, WTSC Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff from U.S. Department of Commerce, Environmental Science Services Administration, Weather Bureau, 1967.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-5

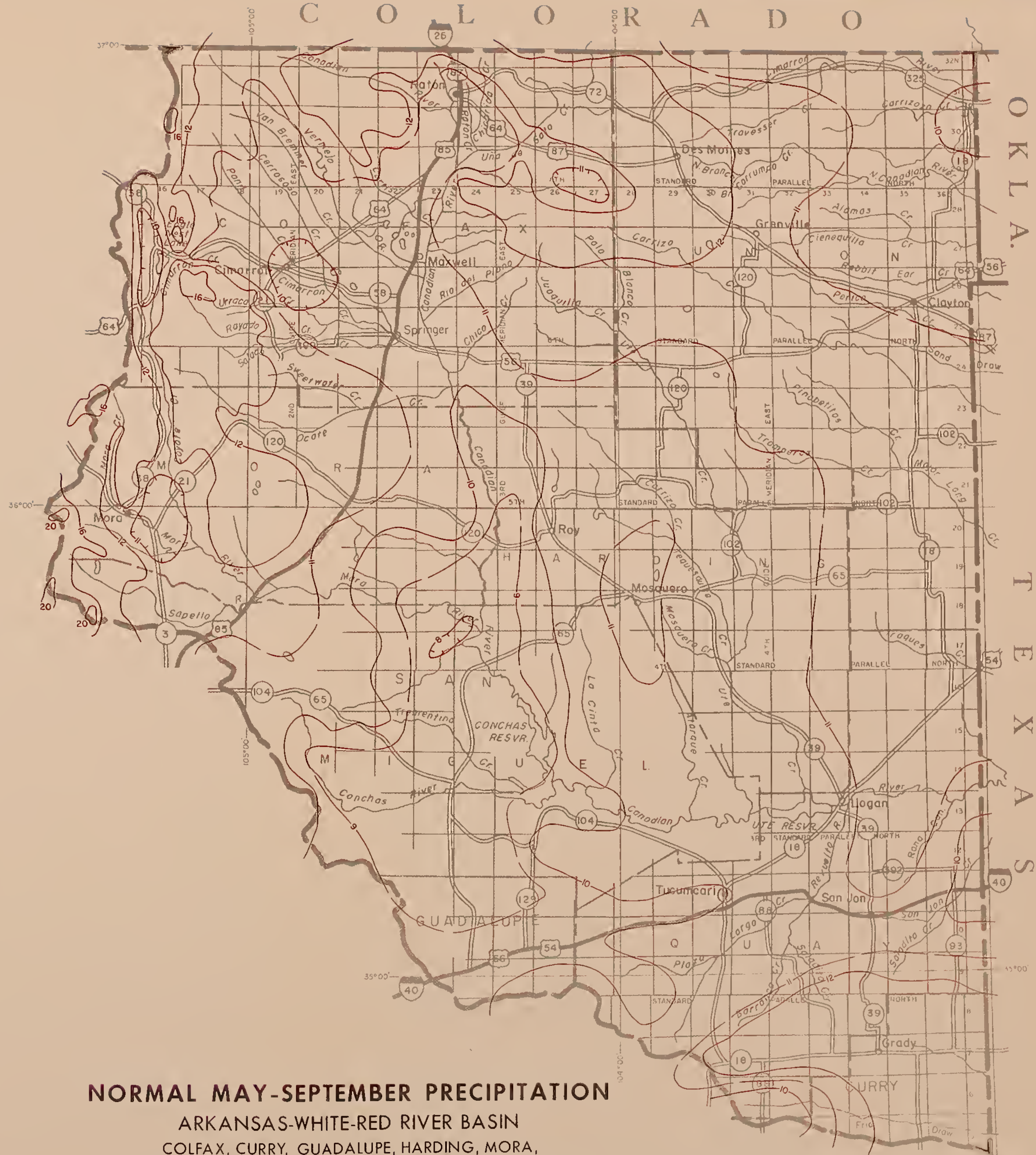
PRECIPITATION

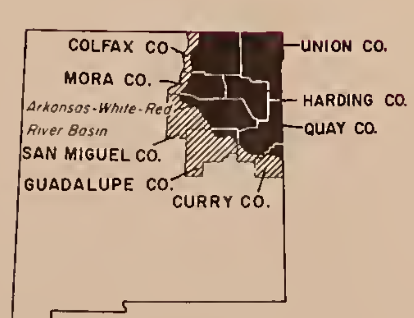
Lines of Equal Precipitation in Inches

Lines of Equal Precipitation in Inches Decreasing Toward Direction of Ticks

Interpolated Lines of Equal Precipitation

Period of Record 1931-1960.





LOCATION MAP

NORMAL MAY-SEPTEMBER PRECIPITATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

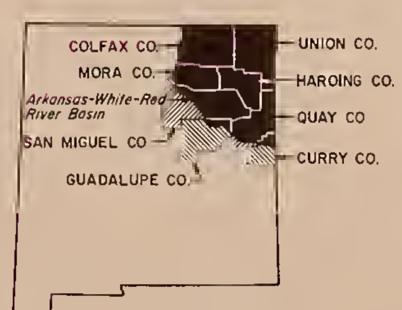
Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-6

TEMPERATURE

—47°— Line of Equal Temperature in Degrees Fahrenheit (Period of Record Through 1954)



LOCATION MAP

AVERAGE ANNUAL TEMPERATURE

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES
SCALE 1:1,200,000

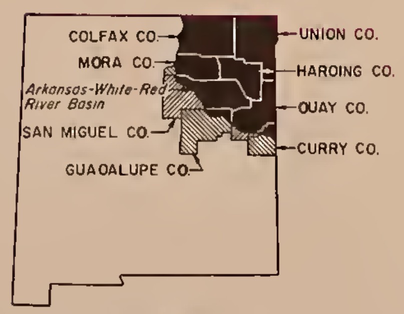
Source:
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff from U.S. Weather Bureau - TP - 5 - 1955.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-7

LAKE EVAPORATION

—75— Lines of Equal Gross Evaporation in Inches



LOCATION MAP

GROSS ANNUAL LAKE EVAPORATION

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source
Base map prepared by SCS, Portland Carto. Unit from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by State Staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22828-4

APPENDIX C SOILS

APPENDIX C

SOILS

APPENDIX C

SOILS

This appendix contains narrative descriptions of general soil associations, seven tables, and two maps.

The soil associations were compiled using the eight county research reports, Soil Associations and Land Classification for Irrigation, published by the Agriculture Experiment Station, New Mexico State University.

The association descriptions include general information about location, extent, soil series, miscellaneous land types in the association, vegetation, and irrigation potential. The irrigation potential is based solely on soil characteristics and not on the availability of water.

The seven tables contain information such as acreages and chemical properties, etc. These tables are computer generated using form Soil Conservation Service SOILS-5 data.

The General Soils map groups the associations by three land resource areas, Pecos-Canadian Plains and Valleys (CP), Southern Rocky Mountains (RM) and Southern High Plains (HP). The map was compiled using the soil association maps for the eight counties that are wholly or partially within the basin.

The Lithologic Group map was compiled using the state geology map and grouping formation of similar lithology into groups.

Soil Association 2
Lacita-Redona-Quay Association

These soils are dominantly deep and formed in alluvial and eolian materials from red-bed formations. This association is dominated by gently sloping to undulating topography with smooth, nearly level, to gently sloping areas bordering the drainageways. This association is located in the extensive valley area below the Las Vegas Plateau in the southern and eastern parts of San Miguel County and the northeastern part of Guadalupe County. It is widely distributed and consists of an area of approximately 504,840 acres.

Lacita soils are deep, well drained, and occur dominantly on nearly level to gently sloping channeled valley bottoms and alluvial fans. They are formed in silty calcareous sediments derived from red-bed formations.

Redona soils are deep, well drained, and occupy the nearly level to very gently undulating plains. They are formed in moderately fine textured calcareous sediments derived from sandstone and shale.

Quay soils are deep, well drained, and occur mainly on gently sloping fans extending from the bases of escarpments and breaks to the lower-lying valleys. They are formed in moderately fine textured alluvium derived from sandstone and shale.

Also included in this association are soils of the Canez, Conchas, La Llande, Montoya, and Alama series. Gullied land also comprises small acreages in this association.

The dominant use of the soils in this association is for livestock grazing. The principal grasses on the loam and clay soils are alkali sacaton, galleta, blue grama, switchgrass, and vine-mesquite. Blue grama, sideoats grama, little bluestem, and sand dropseed are common on the sandy soils. Snakeweed and cholla cactus are the more common shrubs. Some pinyon and juniper occur on the outer fringes of this unit where it joins the escarpment areas.

Although 89 percent of the land in this association has been classified as suitable for irrigation, it varies considerably in its capability for irrigation. Approximately four percent of the land in this association has been placed in irrigation class 1; 42 percent in class 2; 32 percent in class 3; 11 percent in class 4; the remaining 11 percent is nonirrigable, in class 6.

Soil Association 3
San Jon-Los Tanos-Ima Association

These soils are moderately deep to deep and developed dominantly in materials weathered residually from sandstone, interbedded shale and sandstone or in alluvial and eolian materials of similar origin. Included in this association are gently to strongly sloping undulating low hills, upland ridges, mesas, a few steep escarpments and breaks, and nearly level to gently sloping valley bottoms. The association has 63,030 acres in two widely separated areas in the eastern part of Quay County.

San Jon soils are deep, well drained, and formed in medium and moderately fine textured sediments and residuum of shale and interbedded sandstone. They occur on gently to strongly sloping and undulating uplands and low hills.

Los Tanos soils are deep, well drained, and typically occur on nearly level to gently sloping upland ridges and mesas. They formed in sandy and loamy sediments derived mainly from sandstone.

Ima series consists of deep, well drained soils formed in moderately coarse textured sediments occurring on gently to strongly sloping and undulating fans and valley-filled slopes.

Gullied land and soils of the Lacita, Montoya, Quay, La Lande, and San Jose series comprise the remaining parts of this general soils area.

This association supports fair to good stands of native vegetation including short and midgrasses, forbs and shrubs. The more common grasses are blue grama, hairy grama, sand muhly, sand dropseed, threeawn, tobosa, some sideoats grama, little bluestem, needleandthread, and New Mexico feathergrass.

The major soils in this association are nonirrigable or have moderate to severe limitations for use as cropland under irrigation. Although 74 percent of this association is classified as irrigable, the majority of it is in classes 4 and 3. There is 12 percent in irrigation land class 2; 21 percent in class 3; 41 percent in class 4, and the remaining 26 percent is in class 6.

Soil Association 4
Conchas-Latom Association

This association is dominated by shallow and moderately deep soils that formed residually in parent materials of sandstone and shale origin. The included deep soils that commonly occur on the valley-filling slopes and in the valley bottoms formed in medium and moderately fine textured alluvium from sedimentary formations. This association is widespread and consists of approximately 509,210 acres in the southern and eastern parts of San Miguel County and northeastern Guadalupe County. The association occurs generally on gently sloping to rolling landscapes which range in elevation from about 4,000 to 5,800 feet.

Conchas soils are the most extensive in the association. The series is moderately deep, well drained, and formed in sediments eroded from red shale and sandstone. They are on gently undulating uplands.

Latom soils are also an extensive component of this association. These soils are very shallow, well drained, and occur in materials eroded from sandstone. They are on gently sloping to strongly sloping uplands.

Quay soils are deep, well drained, and occur mainly on gently sloping fans extending from the bases of escarpments and breaks to the lower-lying valleys. They are formed in moderately fine textured alluvium derived from sandstone and shale.

Other soils of importance in this association include those of the Quay, Lacita, Redona, Newkirk, and Gallegos series.

This association is used as rangeland and in general supports a fair to good cover of short and midgrasses. The principal grasses include blue grama, galleta, sideoats grama, ring muhly, sand dropseed, and threeawn. Thin and scattered stands of pinyon and juniper are also common on the shallow soils and rock outcrop areas. Other shrubs include rabbitbrush, snakeweed, yucca, and various species of cacti.

Although approximately 59 percent of the land in this association has been classified as suitable for irrigation, it has limited potential for such use. The low capability of many of the soils for irrigation together with the high percentage of nonirrigable land that occurs intermingled throughout the association with the irrigable lands, are the principal reasons for this limited irrigation potential. Approximately 14 percent have been classified as class 2; 5 percent in class 3; 40 percent in class 4; and the remaining 41 percent is nonirrigable in class 6.

Soil Association 5
Redona-Bascom Association

The soils of this association generally have fine sandy loam, loamy fine sand, or light loam surface layers and moderately permeable sandy clay loam or light clay loam subsoils. The included shallow soils are usually underlain by caliche or soil layers containing a high content of lime. These soils formed dominantly in alluvial and eolian materials and occupy nearly level to gently sloping and undulating landscapes. Included in this association are 24,660 acres in four widely distributed areas throughout the central part of Union County.

Redona soils, the most extensive in this association, are deep, well drained, and formed in sediments derived from calcareous sandstone and shale of red bed formations. Redona soils are on smooth, nearly level to gently sloping landscapes.

Bascom soils are well drained and usually occur on undulating to gently rolling, low or slightly elevated ridges. The soils formed in moderately coarse to medium textured mixed sediment with high carbonate content.

Another important member of the association is the Canez series which consists of deep, well drained soils formed in moderately coarse textured alluvium and eolian sediments on alluvial fans. They are on nearly level to gently sloping landscapes.

Other soils of importance or of moderate extent in this association include those of the Douro, and Quay series. Soils of minor extent in this association are the Blakeney, Ratliff, Tucumcari, and San Jose series.

The dominant use of soils in this association is grazing. The more common grasses and shrubs are black grama, blue grama, sideoats grama, sand dropseed, buffalograss, tobosa, sand muhly, New Mexico feathergrass, little bluestem, threeawn, yucca, broom snakeweed, and some mesquite and cholla cactus.

The soils of this association are slightly to moderately susceptible to wind erosion. Generally, this is not a serious problem because of the adequate cover of native vegetation.

Although this association contains a relatively high percentage of nonirrigable land, there is some potential for expansion of irrigation, particularly where the class 2 and class 3 land occurs in tracts of sufficient size to be economically developed. Approximately 53 percent of the land in this unit has been placed in irrigation land class 2; 13 percent in class 3; and the remaining 34 percent is in class 6.

Soil Association 6
Rock outcrop-Orthents-Ustolls Association

Characteristic features of this association are the rough and broken topography, very steep slopes, and rock outcrops. Included are escarpments, steep canyon walls, rocky ridge tops, rock ledges, and steep breaks, all of which are dominated by rock outcrops and patches or small areas of highly variable soils. The escarpment and steep breaks area separating the upland plains on the Las Vegas Plateau from the lower-lying valleys and plains to the south and east is representative of this association. This association includes an area of about 801,130 acres. It is widely distributed, occurring in six counties in the basin.

Rock outcrop, a miscellaneous land type, is an extensive component of this association. It occurs dominantly as escarpments, ridges, sheets, and ledges. It consists of outcrops of interbedded sandstone and shale, and other types of sedimentary rocks.

The Orthents and Ustolls are very shallow to deep, moderately steep to very steep, well drained soils. They formed in residuum, colluvium, and alluvium derived from shale and sandstone on dissected uplands. These soils are so intimately associated that it was not practical to separate them at this level of mapping.

Also in this association are soils of the Bernal, Travessilla, Latom, San Jon, Lacita and La Lande series.

The soil and land types comprising this association are used principally for grazing by livestock and wildlife. This unit supports a wide variety of grasses and shrubs. Blue grama, hairy grama, galleta, sideoats grama, little bluestem, switchgrass, needleandthread, New Mexico feathergrass, sand dropseed and threeawn are the principal grasses. The most common shrubs and woody species include pinyon, juniper, oakbrush, bitterbrush, serviceberry, snakeweed, rabbitbrush, and a few scattered ponderosa pine on north slopes and at the higher elevations. This association provides a good habitat for many species of wildlife.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

Due to the dominance of shallow soils, rock outcrop, and steep, rough broken landscapes, there is little if any opportunity to develop irrigated land in this association. The soils with properties suitable for irrigation occur as small and isolated tracts which will generally preclude their use for irrigation.

Soil Association 7
Gruver-La Brier-Dumas Association

These soils are generally deep and well drained, have a medium to moderately fine textured surface layer and clayey subsoils. The association is on nearly level to very gently sloping landscapes formed in alluvial and eolian materials. This association consists of 735,940 acres in the southeast corner and scattered in the central part of Colfax County; spread across the central part (north to south) in Harding County; and in scattered patches throughout Union County.

Gruver soils, the most extensive in the association, are well drained upland soils formed in eolian sediments. They are on level to gently sloping uplands.

La Brier soils are deep, well drained, and formed in fine textured sediments from sandstone and basalt. They are on the lower parts of concave valley slopes and on floodplains.

Dumas soils are deep, well drained, and occur on nearly level uplands. The soils formed in calcareous eolian materials.

Soils of minor extent in this association include the Dioxice, Sherm, Dallam, and Manzano.

Much of the land in this association is used for range. It supports a relatively dense cover of grass, and moderate to high yields of forage are obtained under good management. The more common species of grass are blue grama, galleta, western wheatgrass, buffalograss, ring muhly, sand dropseed, and threeawn. The association is dry farmed. The principal crops are wheat, sorghum and other small grains.

There is a high potential for development of irrigated land in this association. Irrigation classes 1 and 2 dominate the series. The irrigable soils occur in large tracts with little or no interspersed nonirrigable land. Class 1 soils comprise 47 percent of the association; class 2, 40 percent; class 3, 7 percent; class 4, 1 percent; and class 6, 5 percent.

Soil Association 8
Litle-Berthoud-Penrose Association

These soils range from shallow soils developed over thinly bedded limestone and shale, to thin medium textured soils formed in alluvium. Topography, which is also varied, includes gently sloping and undulating uplands, gently to strongly sloping fans, and gently rolling uplands. Although geographically associated, the soils included in this unit have highly contrasting characteristics. This association includes an area of approximately 53,100 acres in the northwestern part of Harding County.

Litle soils, most extensive in this association, are deep, well drained, and occur on gently sloping to gently undulating uplands. They developed in fine textured material weathered residually from underlying shale.

Berthoud soils are deep, well drained, and occur on gently to strongly sloping fans and valley-filling slopes along the margins of the high plains. These deep soils developed in calcareous medium textured alluvium.

Penrose soils, are shallow, well drained, and are formed in limestone on gently sloping crests and strongly sloping side slopes of ridges.

Manzano, La Brier, and Vermejo soils comprise the remainder of this association.

This association is principally used for grazing. Western wheatgrass, vine-mesquite, galleta, alkali sacaton, and blue grama are the principal grasses on the clayey soils. In addition to these grasses, the strongly sloping shallow and gravelly soils commonly support little bluestem, sideoats grama, New Mexico needlegrass, big bluestem, and threeawn.

The association offers limited opportunity for the development of irrigated land. Thirty-eight percent of the association is in class 2; 12 percent in class 3; 35 percent in class 4; and 15 percent in class 6.

Soil Association 9
Berthoud-Kinkead Association

These soils are predominantly deep and developed in medium to fine textured calcareous alluvium. In general, the area occupied by this unit consists of a relatively broad valley area intermediate between the floodplains of the Ute Creek drainage system and the High Plains. This association includes an area of about 92,550 acres and occurs on gently to strongly sloping fans and plains in the east central part of Harding County.

Berthoud soils are deep, well drained, and occupy the gently to strongly sloping alluvial fans and valley-filling slopes immediately below escarpments or other steeply sloping areas.

The Kinkead soils are deep, well drained, and occur on nearly level to gently sloping broad alluvial fans.

Also in this association are soils of the Bippus and Guadalupe series.

The soils of this association are used for grazing and suppport a moderately dense cover of short and mid-grasses. The principal grasses include tobosa, alkali sacaton, mat muhly, blue grama, and vine-mesquite. Blue grama, sideoats grama, little bluestem, and sand dropseed are common on the soils with sandy surface layers.

A relatively high percentage of the soils in this association have properties suitable for irrigation. Approximately 88 percent of the land in this association has been placed in irrigation land class 2; 8 percent in class 3; and 4 percent in class 4. The soils in class 4 have moderate to severe saline and alkali limitations and will require careful evaluation prior to being developed for irrigation.

Soil Association 10
Church-Karde Association

These soils are predominantly deep and developed in very calcareous alluvial and eolian sediments. This association includes an area of about 19,540 acres in four widely separated areas on the High Plains in the westcentral part of Harding County. A characteristic feature is the enclosed depressions or playas which normally occur in the central part of the areas included in this association. In addition to the playas, this unit includes the nearly level terraces and benches that surround the playas and the gently to strongly sloping and undulating side slopes.

The Church soils are deep, somewhat poorly drained, and occur on nearly level to very gently sloping low terraces or benches that surround depressional areas or playas. They are formed in clayey calcareous, moderately alkaline water deposited sediments.

Karde soils are deep, well drained, and developed in calcareous eolian sediments on the leeward side of playas or enclosed depressions. They dominantly occur on that part of the association which has an undulating or dune topography.

Other soils of importance in this association include those of the Campus, La Brier, and Manzano series.

Most of the association is used as native rangeland and, when properly managed, affords good grazing. Native vegetation on the Church soil is principally western wheatgrass, alkali sacaton, and inland saltgrass. Blue grama, galleta, buffalograss, with minor amounts of sideoats grama, and needlegrass are the dominant grasses on the other soils.

The major soils of this association have moderate to severe limitations for use as cropland under irrigation. Although this association contains a relatively high percentage of land classified as irrigable, the majority of it is in classes 3 and 4. Ten percent of the association is class 2; 35 percent is class 3; 45 percent is class 4; and 10 percent is class 6.

Soil Association 11
Campus-Dean Association

This association includes those areas where calcareous soils developed over relatively thick beds of caliche are dominant. Although these soils normally occupy gently sloping to undulating landscapes, they occur on nearly level areas. This association, approximately 166,650 acres, is extensive on the High Plains in the west, central, and northeastern parts of Harding County.

Campus soils are moderately deep, well drained, and occur on nearly level to gently sloping uplands. The soil is formed in highly calcareous, partially consolidated, old alluvium

Dean soils are well drained and typically occupy the gently to moderately sloping crests and side slopes of upland ridges and knolls. The soils formed in sediments derived principally from limestone. Claiche is at shallow depths.

Included in this association are small acreages of Dioxice, Dumas, Manzano, and Pastura soils.

Most of this association is in range use. The native vegetation consists of a mixture of mid and short grasses with a scattered stand of shrubs. The more common grass species are blue grama, hairy grama, sideoats grama, sand dropseed, and little bluestem.

Campus soils, the most extensive in the association, are susceptible to wind erosion because of their fine granular and strongly calcareous surface soils. These soils will require good soil management to prevent wind erosion.

Although irrigation classes 3 and 4 are relatively extensive, approximately one-fifth of the land in this association is in classes 1 and 2. About 6 percent of the land in this unit has been included in class 1; 13 percent in class 2; 21 percent in class 3; 34 percent in class 4 and the remaining 32 percent in class 6.

Soil Association 12
Mansker-Portales Association

These soils, which have calcareous fine sandy loam surface layers, developed in calcareous, alluvial, and eolian materials overlying caliche or alluvial sediments with a high lime content. The association consists of approximately 34,310 acres and includes a number of widely separated areas in the eastern part of Harding County. A gently sloping to undulating type of topography prevails throughout the areas included in this unit.

Mansker soils are well drained and occur on gently to strongly sloping and undulating upland landscapes. The soils are formed in calcareous, loamy eolian material.

Portales soils are deep, well drained, and occur on nearly level to gently sloping and undulating surfaces. The soils are formed in calcareous alluvial sediments.

In addition to Mansker and Portales soils, approximately 15 percent of this association is comprised of a number of other soils and miscellaneous land types. Potter soils and small, widely separated areas of wet unnamed alluvial soils are also of importance in this unit.

The soils of this unit are used principally as rangeland. These soils support a mixture of mid and short grasses including blue grama, sideoats grama, sand dropseed, little bluestem, hairy grama, and threeawn.

In addition to range use, a very small acreage in this association is farmed under irrigation. Forage and grain sorghums are the principal crops produced.

The moderately deep Portales soils have a moderate wind erosion hazard. Soil management practices to control damage from wind erosion will be essential due to the sandy textured surface layers.

In this association there is 30 percent in irrigation land class 2; 19 percent in class 3; 36 percent in class 4; and 15 percent in class 6.

Soil Association 13
Otero-Dalhart Association

These soils, which are generally deep and sandy, developed in alluvial and eolian sediments. Although the topography ranges from nearly level to gently rolling, an undulating to gently rolling landscape is the most common. The association comprises an area of about 36,280 acres on the High Plains in the north central part of Harding County.

Otero soils are deep, somewhat excessively drained, and formed in wind reworked sediments on fans and uplands. They usually occupy the undulating to gently rolling landscapes.

The Dalhart soils are deep, well drained, and formed on upland eolian sediments. These soils occur on nearly level to gently undulating landscapes.

Also of importance in this association are soils of the Manzano, Tapia, and Campus series.

This association is used mainly as native range with vegetation consisting dominantly of mid and tall grasses. The more common grasses are little bluestem, sand bluestem, sideoats grama, sand dropseed, and blue grama. In addition to range use, a small acreage of Dalhart fine sandy loam is dry farmed. Grain and forage sorghum, millet, and sudan grass are the main crops produced.

The major soils of this association are suitable for use as cropland under irrigation. There is 30 percent of the association in irrigation land class 1; 9 percent in class 2; 60 percent in class 3; and 1 percent in class 4.

Soil Association 14
Amarillo-Springer Association

The major and more extensive soils of this association are deep, well drained, and have moderately coarse textured surface layers. Included in this association are four widely separated areas in the eastern part of Harding County and in the northwestern part of Quay County. They comprise an area of about 296,730 acres. In general, this association is characterized by a sloping and undulating topography.

Amarillo soils are deep, well drained, and formed in old upland eolian or alluvial materials. They are on nearly level to gently sloping uplands.

Springer soils are deep, well drained, and formed in sandy alluvial materials. They occur dominantly on the gently sloping and undulating landscapes.

Although not included in the name, the Brownfield series is a prominent part of the association and consists of deep, well drained undulating soils on uplands. It formed in eolian materials.

Also of importance in this association are soils of the Bascom, and Gomez series. Tivoli, Potter, and Gallegos Series occur to a very limited extent.

The main use of this association is range with a limited acreage of dry cropland. These soils support a good cover of grass with blue grama, hairy grama, little bluestem, sideoats grama, and sand dropseed being the more common species. Grain and forage sorghums, broomcorn, and sudan grass are the main crops produced.

Ninety percent of this association is suitable for irrigation. Fourteen percent of the association is in irrigation class 1; class 2 has 40 percent; class 3 has 29 percent, and class 4 has 7 percent. The remaining 10 percent is nonirrigable and is in class 6.

Soil Association 15
Springer-Tivoli-Amarillo Association

These soils are dominantly deep and sandy and developed in sandy eolian materials. Smaller areas of shallow soils over caliche or very limy sediments occur locally in the interdune areas. This association has 361,810 acres in the eastern part of Harding County, in a band across the northern part of Quay County, and in the bottom of Frio Draw in Curry County. A characteristic feature of this association is the undulating to gently rolling or dune landscape. A few of the dunes are bare of vegetation and actively erode during windy periods. It is referred to locally as the "sand hills."

Springer soils are deep, well drained, and formed in eolian sediments. They occur dominantly on gently undulating landscapes.

Tivoli soils are deep, excessively drained, and occupy the gently rolling to dune terrain. Tivoli soils have loose and extremely sandy profiles.

Amarillo soils are deep, well drained upland soils formed in old eolian deposits. Although locally slightly hummocky or undulating, they usually occur on nearly level to gently sloping landscapes.

Mansker and Potter soils are also in this association.

This association is used as rangeland. The native range has the potential to support a mixture of tall and mid grasses including such species as little bluestem, big bluestem, sideoats grama, indiangrass, switchgrass, giant sandreed, and black grama. Sand sagebrush, yucca, wild plum, and mesquite are the common shrubs.

Soils in this association have moderate to severe wind erosion hazard under cultivation. Good conservation management practices are essential to minimize wind erosion damage on soils with a moderate hazard. Soils with severe hazard should not be cultivated.

About 62 percent of the soils in this association are considered suitable for irrigation. Seven percent of the land is in irrigation class 1; 13 percent in class 2; 39 percent in class 3; and 3 percent is in class 4. The remaining 38 percent is in class 6.

Soil Association 16
Apache-Torreon-Tricon Association

These soils range from shallow to deep, are dark-colored, and are often stony or cobbly. Included in this association are soils formed dominantly in materials of volcanic or basic igneous origin on lava flows, cinder cones, and basalt-capped mesas. It consists of an area of about 717,210 acres, located primarily in the east central part of Colfax County, in the north central edge of Harding County, and scattered through a large area of central and western Union County.

Apache are shallow, well drained soils formed in residuum on gently sloping and undulating crests of old lava flows and on the outer fringes of basalt-capped mesas.

Torreon series are deep, well drained soils formed in mixed eolian and alluvial fans with sediments derived principally from basalt. They usually occupy the nearly level to gently sloping landscapes in this association.

Tricon soils are moderately deep, well drained soils formed in old alluvium and eolian sediments. They are on broad upland plains.

Less extensive soils in this association include the DeMaya, Capulin, Thunderbird, Dioxice, Carnero, Travessilla, Bernal, La Brier, and Pastura series. Rock outcrop is common on the fronts and sides of lava flows. Sandstone rock outcrop also occurs to a limited extent.

This association is used for grazing by livestock and wildlife and supports a relatively dense cover of native vegatation. The more common grass species are blue grama, sideoats grama, little bluestem, big bluestem, western wheatgrass, galleta, buffalograss, indiangrass, New Mexico feathergrass, and threeawn. Thin stands of juniper, pinyon pine, oakbrush, and other shrubs commonly occur on the breaks and high elevations.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

Approximately 62 percent of the land in this association has been classified as suitable for irrigation. Forty-three percent is in irrigation land class 2; 7 percent is in class 3; and 12 percent is in class 4. Thirty-eight percent is nonirrigable in class 6.

Soil Association 17
Travessilla-Carnero-Rock outcrop Association

Most of the soils in this unit are developing residually in materials weathered from sandstone, with other sedimentary rocks contributing minor amounts. Locally, and particularly where the soils are moderately deep or deeper, there have been additions of eolian and alluvial sediment. Included in this association are gently sloping to moderately steep and rolling uplands underlain predominantly by sandstone bedrock. The association is widespread and the largest in the AWR includes 944,130 acres in Colfax, Harding, Mora, San Miguel and Union Counties. Steep canyon walls, escarpments, and breaks located adjacent to the Canadian River also comprise a small acreage in this association.

The Travessilla series consists of shallow and very shallow, well drained soils on gently sloping to moderately steep sandstone hills, mesas and breaks. It formed in residuum from sandstone with some eolian influence.

Carnero soils are moderately deep and well drained. They occupy gently to strongly sloping and undulating uplands and are formed in mixed eolian sediments and residuum from sandstone.

Rock outcrop, the other major component in this association, consists of outcrops of sandstone and other types of sedimentary rocks. The outcrops commonly occur as vertical or nearly vertical exposures or ledges, sheets and benches.

Other soils of importance in this association include those of the Bernal, Kim, Rednun, and Manzano series.

Soils of this association are in native range. The soils support a relatively good mixture of mid and short grasses including such species as blue grama, sideoats grama, sand dropseed, galleta, and little bluestem. Thin stands of juniper and pinyon trees, oak and other shrubs are common on the Travessilla soils and steep Rock outcrop areas.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

The potential for development of irrigation land in this association is very limited. Approximately 2 percent of the land in this association is in class 1; 4 percent is in class 2; 4 percent is in class 3; 19 percent is in class 4; and 71 percent is in class 6.

Soil Association 18
Gallegos Association

Although this association is characterized by moderately steep and hilly topography, small areas of valley bottoms, alluvial fans, and other tracts of land with nearly level to gentle relief are included. The general soils area includes 38,460 acres in the extreme northcentral part of Harding County.

Gallegos series consists of deep, well drained soils which developed in calcareous gravelly alluvium on old dissected stream terraces. They are on gently sloping to moderately steep landscapes.

Latom-Rock outcrop complex and soils of the Ima and Quay series also comprise a small percentage of this association.

Rangeland is the principal use of this association. Short and mid grasses are the more common ground cover. The principal grasses include blue grama, black grama, sideoats grama, galleta, tobosa, little bluestem, and threeawn. It also supports a thin stand of pinyon and juniper.

There is very little, if any, potential for the development of irrigation land in this association. The steep slopes and shallow soils in this association tend to limit its use.

Soil Association 19
Spurlock-Texline Association

Included in this association are areas that are dominated by soils formed in calcareous loamy sediments of eolian and alluvial origin. Most of the soils have calcareous surface layers and subsurface layers which are high in lime. Although these soils frequently occupy gently to strongly sloping and undulating landscapes adjacent to intermittent drainages, they also occur on nearly level to gently sloping plains. This association comprises an area of about 340,970 acres and occurs in most parts of Union County except the north and northwestern parts and along the north edge of Quay County.

Spurlock soils are deep, well drained, and formed mainly in calcareous eolian materials. They occur on nearly level to gently sloping and undulating upland plains and valley slopes.

Texline soils are deep, well drained, and formed in calcareous loamy eolian materials. They are on nearly level to gently sloping surfaces.

Also in this association is the Plack series which consists of shallow, well drained, nearly level to gently sloping soils in upland areas. The soil is formed in calcareous, loamy wind deposited materials.

Other soils in this general soil area include those of the Guy, Kim, Manzano, Dallam, Gruver, and Dioxice series.

This association is dominantly in range use. The principal native grass species are sideoats grama, blue grama, hairy grama, sand dropseed, threeawn, and also silver bluestem, little bluestem, sand muhly, and buffalograss. The more common shrubs are small soapweed, broom snakeweed, and cholla cactus.

Although approximately 68 percent of the land in this association has been classified as suitable for irrigation, its potential for such use is somewhat limited. Three percent of the land in this association has been placed in irrigation class 1; 27 percent is in class 2; 29 percent is in class 3; 9 percent is in class 4; and 32 percent is in class 6.

Soil Association 20
Colmor-Litle Association

These soils are dominantly moderately deep and deep and range from shallow to deep. They formed mainly in materials weathered from shale and other interbedded sedimentary rocks. In the units of this association occurring in the southeastern part of Union County, soils developing in calcareous eolian sediments are also quite common. This association, which comprises an area of about 64,400 acres, includes numerous small areas that are widely distributed throughout the central and southwestern parts of Union County. The topography, which is variable, is dominated by nearly level to strongly sloping and undulating uplands. Playas or small basin areas where surface runoff accumulates are quite common.

Colmor soils are deep, well drained, and formed in fine textured residuum from shale on uplands. They are mainly on nearly level to gently sloping and undulating uplands and side slopes of ridges.

Litle soils are moderately deep and well drained soils formed in residuum from clay shale. They occur on gently to strongly sloping and undulating uplands.

The Kim series is also a significant part of the association and consists of deep, well drained soils that formed in alluvium mainly from sandstone and shale. It is on alluvial fans below escarpments of sedimentary rock.

Also included in this association are La Brier, Vermejo, and Manzano soils.

The soils of this association are used dominantly for grazing of livestock and wildlife and support a fair to good cover of native vegetation. They consist mainly of blue grama, western wheatgrass, galleta, vine-mesquite, alkali sacaton, and some winter and fringed sagewort. Thin and scattered stands of juniper and oakbrush also occur on some of the steeper slopes.

A high percentage of the soils in this association have moderate to severe limitations for use as cropland under irrigation. There is no irrigation class 1 land in the association; 22 percent is in class 2; 39 percent is in class 3; 22 percent is in class 4; and the remaining 17 percent is in class 6.

Soil Association 21
Dallam-Rickmore Association

In general, these soils occupy gently sloping and undulating landscapes, but small wind-eroded areas with gently rolling and dune topography are included in this general soil area. The most extensive soils have fine sandy loam or loamy sand surface layers. This association, comprising an area of about 336,020 acres, occurs in all parts of Union County except the northern and northwestern areas. Although widely distributed, the larger and more extensive delineations occur in the southern part of Union County.

Dallam soils are deep, well drained, and formed in loamy or sandy eolian materials. They occur on gently sloping and undulating landscapes.

Rickmore series consist of deep, well drained soils formed in loamy eolian materials. They occupy nearly level to gently sloping and undulating landscapes.

The Vingo series, also a prominant soil in the association, consists of deep, well drained, undulating to hummocky soils on uplands. It formed in sandy eolian materials.

Also of moderate extent in this association are soils of the Spurlock series. Twenty percent of this association consists of a number of other soils and miscellaneous land types, including those of the Valent, Bankard, Guy, and Plack series.

The dominant use is range, but a small acreage in this association is cultivated under irrigated and dry farming. The soils of this association usually support a good cover of native vegetation, with blue grama, sideoats grama, little bluestem, big bluestem, indiangrass, needleandthread, galleta, sand muhly, sand dropseed, and threeawn being the more common species. The principal shrubs are sand sagebrush, broom snakeweed, yucca, and various species of cacti. Grain and forage sorghums, small grains, corn, and alfalfa hay are the principal crops. In addition to range and cropland uses this soil area is a good wildlife habitat, particularly for game birds.

Some soils in this association have moderate to severe wind erosion hazard under cultivation. Good conservation management practices are essential to minimize wind erosion damage on soils with moderate hazard. Soils with high and severe hazard should not be cultivated.

The major soils of this association have characteristics and properties favorable for their use as irrigated cropland. Approximately 25 percent of the land in this general soil area has been placed in irrigation land class 1; 35 percent in class 2; 19 percent in class 3; 12 percent in class 4; and the remaining 9 percent in class 6.

Soil Association 22
Manzano-Alicia Association

These soils, which are forming dominantly in medium to moderately fine textured alluvium of mixed origin, are typically deep and well drained. They are principally on nearly level to gently sloping floodplains of the Cimarron River and adjacent tributary drainages, as well as on the strongly sloping coalescing alluvial fans or valley slopes that extend from the base of the escarpments or canyon walls to the floodplains. This association, which roughly parallels the Colorado-New Mexico state line in the northern part of Union County comprises an area of approximately 91,710 acres.

Manzano series consists of deep, well drained soils formed on alluvium. They commonly occur on nearly level to very gently sloping floodplains.

Alicia soils are deep, well drained, and formed in medium to moderately fine textured silty sediments derived principally from red-bed formations. Typically, they occupy the gently to strongly sloping valley side slopes that extend from the base of escarpments or canyon walls toward valley bottoms.

The Kim series is also a significant part of the association and consists of deep, well drained soils that formed in alluvium mainly from sandstone and shale. It is on alluvial fans below escarpments of sedimentary rock.

Other soils in this association are small areas of Rock outcrop and soils of La Brier, Rizozo, Escabosa, and Travessilla series.

The soils of this association are used mainly for grazing of livestock and wildlife and, in general, support a good cover of vegetation consisting of a mixture of mid and short grasses. Blue grama, sideoats grama, galleta, alkali sacaton, western wheatgrass, ring muhly, switchgrass, and threeawn are some of the more common grasses. Shrubs and woody species include broom snakeweed, rabbitbrush, Apacheplume, yucca, various species of cacti, and some pinyon pine, juniper, serviceberry, and oak.

Approximately 89 percent of the land in this association has been classified irrigable. In general, the only lands not irrigable are the small areas of Rockland and shallow soils, the immediate floodplain of the Cimarron River, and arroyo bottoms. About 22 percent of the land in this unit has been placed in irrigation land class 1; 63 percent in class 2; and 4 percent in class 3. The remainder is in class 6.

Soil Association 23
Aridic Argiustolls-Rock outcrop Association

This association is extremely variable ranging from deep to shallow, stony to nonstony, and moderately steep to steep. The slopes are short and range from 20 to 35 percent gradient. These soils formed in colluvium, alluvium, and residuum derived from sandstone, shale, limestone, and basalt. The soil association consists of 190,300 acres in the northeast and southwest parts of Colfax County and in the northwest corner of Union County.

Aridic Argiustolls are extremely variable and occur on moderately steep and rolling alluvial fans and valley-filling slopes. They range from stony to nonstony, from deep to shallow, and are present throughout the association.

Rock outcrop consists of basalt, sandstone, shale, and limestone. Throughout the exposures it is in the near vertical escarpments at the higher elevations and occur as ridges and isolated exposures.

Minor soils in this association include Des Moines, Raton, Vermejo, Burnac, Fuera, and Mion.

This association is used for range, wildlife habitat, and recreation. Natural vegetation is blue grama, western wheatgrass, Arizona fescue, little bluestem, gambel oak, mountainmahogany, pinyon pine, oneseed juniper, and ponderosa pine.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

This association is not suitable for irrigation.

Soil Association 24
Colmor-Swastika Association

This association consists of deep silty loam and silty clay loams on uplands These soils formed in residuum and alluvium derived from shale. The association consists of 557,520 acres in the northcentral, central, and southcentral parts of Colfax County and northwestern Mora County.

Colmor soils are deep, well drained, and formed in residuum from shale on uplands. They are mainly on the sides of ridges and fans or on the nearly level to gently sloping and undulating areas.

Swastika series consist of deep, well drained soils formed in fine textured residuum from shale and commonly occupy the smoother and nearly level to gently sloping landscapes in this association.

The Kim series is also a significant part of the association and consists of deep, well drained soils that formed in alluvium mainly from sandstone and shale. It is on alluvial fans below escarpments of sedimentary rock.

Minor soils including La Brier, Berthoud, Mion, Litle, Vermejo, Manzano, and Tinaja make up about 26 percent of the association.

This association is used for range, irrigated crops, wildlife habitat, and recreation. Natural vegetation is mainly blue grama, galleta, sand dropseed, and western wheatgrass. The dominant cultivated crops are alfalfa, corn, and small grains. Rangeland units are usually large.

There is a high potential for development of irrigated land in this association. Ninety percent of the soils is suitable for irrigation. About 3 percent of the land is in irrigation land class 1; 75 percent is in class 2; 6 percent is in class 3; 6 percent is in class 4; and 10 percent is considered not suitable for irrigation.

Soil Association 25
Mion-Vermejo-Litle Association

This association has shallow to deep, moderately well and well drained silt loam and silty clay loam soils formed in residuum and alluvium derived from shale. This association is level to hilly on uplands, fans, swales, and low hills. It consists of 418,240 acres in the central, northcentral, and southcentral parts of Colfax County and is scattered along the eastern quarter of Mora County.

Mion soils are shallow, well drained, and formed in shale residuum on hills, ridges.

Vermejo series are deep, moderately well drained soils that formed on broad, nearly level and gently sloping alluvial fans and wide flat drainageways.

Litle series are moderately deep, well drained soils occuring on gently sloping to gently undulating uplands. They developed in moderately fine textured material, weathered residually from the underlying shale.

About 48 percent of the association includes Penrose, Reno Hill, Midway, Manzano, Colmor, Swastika, and Tinaja soils.

This association is used for range, irrigated cultivated crops, wildlife habitat, and recreation. Natural vegetation is blue grama, buffalograss, alkali sacaton, inland saltgrass, western wheatgrass, galleta, sideoats grama, fourwing saltbush, and scattered pinyon pine and oneseed juniper. Principal cultivated crops are alfalfa and corn.

The potential for irrigation development is limited. The percentage of soils suitable for irrigation makes up about 60 percent of the association. There is 25 percent in class 2; 20 percent in class 3; 15 percent in class 4; and 40 percent in class 6.

Soil Association 26
Raton-Barela Association

This association is very shallow to deep silt loam, stony silt loam, stony loam, and cobbly loam formed in residuum and alluvium derived from basalt and is modified by mixed eolian materials. This association has about 92,920 acres on basalt-capped mesas in the northeast and southwest parts of Colfax County. Slopes range from 0 to 50 percent but for the most part are 0 to 15 percent.

Raton soils are shallow, well drained, formed on basalt-capped mesas and formed in fine textured residuum weathered mainly from basalt. They are on gently sloping to moderately steep landscapes.

Barela soils are deep and well drained. They are on nearly level to moderately sloping basalt-capped mesas and formed in residuum weathered mainly from basalt.

Hillery, Yankee, Dalcan, Saladon, Burnac, and Bandera soils and Rock outcrop make up about 25 percent of the association.

This association is used for range, limited cultivated crops, wildlife habitat, recreation, and watershed. Natural vegetation is blue grama, Arizona fescue, western wheatgrass, mountain muhly, pine dropseed, prairie junegrass, big bluestem, and little bluestem. Cultivated crops are small grains and alfalfa.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

The potential development of irrigated land in this association is limited. There is 16 percent of the association in irrigation land class 3; 44 percent in class 4; and 40 percent in class 6.

Soil Association 27
Morval-Moreno-Brycan Association

This association has deep loam soils formed in alluvium derived from igneous intrusive and sedimentary rocks. This association has about 57,410 acres in western Colfax County. This association is gently sloping to moderately steep mountain valleys.

Morval series consists of deep, well drained soils formed in mixed alluvium from shale, sandstone, and acid igneous rock on alluvial fans in wide mountain valleys. The surface is gently and moderately sloping with smoothly convex relief.

Moreno soils are deep, well drained on valley sides. They are formed in fine textured material weathered from sandstone, shale and acid igneous intrusive rocks.

Brycan series are very deep, well drained soils formed on alluvial fans. They are formed from limestone and sandstone derived sediments on gently sloping to moderately steep alluvial fans and valleys.

Ring, Cypher, Vamer, Dargol, and Saladon soils and Rubble land, Rock outcrop, and Cumulic Haplaquolls make up about 25 percent of the association.

This association is used for range, cultivated crops, wildlife habitat, and recreation. Natural vegetation is blue grama, mountain muhly, bottlebrush squirreltail, Kentucky bluegrass, western wheatgrass, and Arizona fescue. Cultivated crops are alfalfa and small grains.

Although approximately 92 percent of the land in this association has been classified as suitable for irrigation, it offers only limited opportunity for expansion of irrigation. Approximately 51 percent of the land in this association is in class 2; 33 percent in class 3; 8 percent in class 4; and the remaining 8 percent is nonirrigable, in class 6.

Soil Association 28
Bundo-Angostura-Tolby Association

This association is deep, cold, stony sandy loam, stony fine sandy loam and gravelly loam formed in colluvium, alluvium, and residuum derived from igneous intrusive rocks, sandstone, and shale. This association is on wooded mountain sides. It consists of about 172,800 acres in the western part of Colfax County.

Bundo series are deep, well drained soils formed in colluvial-alluvial materials from acid igneous intrusive rock. They are on steep and very steep, stony and gravelly convex mountain slopes.

Angostura series consists of deep, well drained soils formed in colluvium from sandstone and shale on mountains.

Tolby soils are deep and excessively drained. They formed in colluvium from acid igneous rocks. They are on very steep, stony, convex mountain slopes.

Cypher, Etoe, Etown, Wellsville, Abreu, Moreno, Morval, and Saladon soils, Rock outcrop, and a group of soils called Ustochrepts make up about 30 percent of the association.

This association is used for woodland, wildlife habitat, and recreation. Natural vegetation is Douglas-fir, white fir, Englemann spruce, sub-alpine fir, bristlecone pine, and quaking aspen. The understory is kinnikinnick, Oregon-grape, mockorange, and mountain grasses.

This association is dominated by deep, stony and gravelly soils on steep and very steep mountainous landscapes; hence, there is essentially no opportunity for development of irrigated land. All land in this association has been included in irrigation land class 6.

Soil Association 29
Burnac-Fuera-Hillery Association

This association consists of well drained stony loam and cobbly loamy soils formed in colluvium-alluvium and residuum derived from basalt, sandstone, and shale. There are 133,400 acres of this in southwestern Colfax County. It is sloping to steep and is on basalt flows and mountain sides.

Burnac series are deep, well drained soils on gently sloping to moderately steep, convex basalt flows. The soils formed in stony, fine textured residuum weathered from basalt.

Fuera series are deep, well drained, and formed in colluvial-alluvial material from sandstone, shale and acid igneous rock. They are on steep to very steep mountain slopes.

Hillery series are deep, well drained, and formed in fine textured residuum from basalt on mesas and flows. They are on gently sloping to moderately steep landscapes.

Rock outcrop, Saladon, Raton, and Brycan soils make up about 10 percent of the association.

This association is used for woodland, wildlife habitat, and recreation. Natural vegetation is Douglas-fir, white fir, limber pine, quaking aspen, Englemann spruce, and ponderosa pine. The understory is Gambel oak and mountain grasses.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

The potential for development of irrigated land in this association is limited. There is 1 percent of the association in irrigation land class 3; 14 percent in land class 4; and the remaining 85 percent in class 6.

Soil Association 30
Etoe-Etown-Angostura Association

This association is characterized by mountainous topography that ranges from gently to strongly sloping on the ridge tops to steep and very steep on the side slopes that extend down from the broad ridge tops into the deep canyons. Soils developed on weathered bedrock of sandstone, shale, limestone, and some conglomerate. Typically, they have gravelly or stony medium and moderately coarse textured surface layers that are neutral or slightly acid in reaction. A forest litter of 2 or more inches commonly covers nearly all of the soil surface. There are about 131,930 acres in this association along the eastern slopes of the Sangre de Cristo Mountains in Colfax, Mora, and San Miguel Counties.

The Etoe series are deep, well drained, and formed in alluvial-colluvial material from sandstone and shale. They are on steep and very steep mountain slopes.

The Etown series are deep, well drained, and formed in colluvial-alluvial materials from sandstone and shale on steep mountain slopes. They are on steep to very steep mountain toe slopes.

The Angostura series is deep, well drained, and formed in colluvium from sandstone and shale. They are on moderately sloping to extremely steep mountain sides.

About 10 percent of this association includes the Lobert and Lobert-like soils, alluvial soils and Rock outcrop.

This association is used for timber production, recreation, wildlife habitat, and some livestock grazing. The natural vegetation is dominated by tree species. The more common are Englemann spruce, Douglas-fir, white fir, limber pine, subalpine fir, bristlecone pine, common juniper, and aspen. The understory includes kinnikinnick, whortleberry, rose, Oregon-grape, pussytoes, and yarrow.

The only soils with characteristics suitable for irrigation are the deep alluvial soils. These soils are not extensive and are widely distributed. They commonly occur as very small and irregular shaped tracts that will tend to preclude their use for irrigation.

Soil Association 31
Dargol-Fuera-Vamer Association

This association consists of very shallow, moderately deep and deep, well drained, stony loam, stony very fine sandy loam, and cobbly loam soils formed in colluvium, alluvium, and residuum derived from sandstone and shale. This association is on wooded, brushy, and grass mesas and mountain sides and consists of about 735,070 acres in the northern part of Colfax County and the central western part of Mora County.

The Dargol series consists of moderately deep, well drained soils formed in fine textured residuum from shale and sandstone on ridges, mountain slopes, and mesas. They are on sloping to steep surfaces.

The Fuera series consists of deep, well drained soils formed in colluvial-alluvial materials derived from sandstone, shale and acid igneous rocks. They are on steep mountain slopes.

The Vamer series consists of shallow, well drained soils formed over sandstone on ridges, mesas, and foothills. It is on moderately sloping to moderately steep slopes.

Also in this association are soils of Midnight, Sanchez, and Rombo series, unclassified alluvial soils, and Rock outcrop.

This association is used for woodland, range, wildlife habitat, and recreation. Natural vegetation is Douglas-fir, white fir, ponderosa pine, pinyon pine, Rocky Mountain juniper, and oneseed juniper with an understory of Gambel oak, mountainmahogany, mountain muhly, pine dropseed, big bluestem, little bluestem, blue grama, and sideoats grama.

Because of rough-broken and mountainous topography and steep slopes, there is no potential for development of irrigation in this association. All the land in this unit is included in irrigation land class 6 which is nonirrigable.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

Soil Association 32
Torreon-Thunderbird-Crews Association

These soils, which range from shallow to deep, formed dominantly in materials derived from basalt or other volcanic materials. Included in this association are nearly level to gently sloping and undulating plains with a limited area of strongly sloping to moderately steep topography. These more sloping areas usually occur on the sides and terminal points of the lava flows or those parts of the association that slope toward the intermittent drainageways. This association includes an area of about 173,560 acres in north central Mora County.

The Torreon series are deep and very deep, well drained soils formed in eolian and alluvial sediments from basalt on basalt-capped mesas. Torreon soils usually occupy the more level and slightly depressional areas in this association.

The Thunderbird series are deep, well drained soils formed in fine textured materials weathered from basalt on nearly level to steep basalt hills.

The Crews series consists of shallow, well drained fine textured soils that formed in mixed materials on uplands and ridges. They are on nearly level to gently sloping landscapes.

Soils of lesser extent in this association include the Capulin, and Rudd series. Basalt Rock outcrop, a miscellaneous land type, also comprises a small acreage in this association.

This association is used for grazing livestock and wildlife and supports a relatively dense cover of native vegetation. The dominant or more common species are blue grama, wolftail, western wheatgrass, sideoats grama, galleta, vine-mesquite, threeawn, broom snakeweed, and fringed sagewort.

Approximately 68 percent of the land in this association has been classified as suitable for irrigation. There is 38 percent of this association in irrigation land class 2; 5 percent in class 3; 25 percent in class 4; and 32 percent in class 6.

Soil Association 33
Rednun-Carnero-Tricon Association

These soils are dominantly moderately deep and deep, well drained, and formed on sandstone or indurated caliche. The soils formed on nearly level to gently undulating topography with slopes seldom exceeding 5 percent. The association consists of about 325,900 acres in south central, southeast, and eastern Mora County and is scattered through north central San Miguel County.

The Rednun series are deep, well drained soils formed in calcareous alluvial fan sediments derived from shales and limestone. They are on gently to moderately sloping landscapes.

The Carnero series consists of moderately deep, well drained soils formed in mixed eolian sediments and residuum from sandstone on uplands and mesa types. It is also located in the nearly level to gently sloping landscapes adjacent to drainageways.

The Tricon series consists of moderately deep, well drained soils formed in old alluvium and eolian sediments on uplands. They are on nearly level to gently sloping landscapes.

Minor soils such as Bernal, Travessilla, Crews, Manzano, and La Brier make up the remainder of the association.

This association supports a good cover of grass with blue grama, galleta, western wheatgrass, mesa dropseed, ring muhly, and threeawn being the more important species. A few woody species, consisting dominantly of juniper, may also occur along the margins of this unit.

The irrigation capability of the land in this association varies widely; there is considerable potential for expansion of irrigation. Approximately 36 percent of the association has been placed in irrigation land class 1; 17 percent in class 2; 22 percent in class 3; 10 percent in class 4; and the remaining 15 percent in nonirrigable class 6.

Soil Association 34
La Brier-Manzano-Loma Association

The soils in this association are generally deep and dark-colored, and formed in medium to fine textured alluvial sediments of mixed origin. Included in this association are nearly level to gently sloping valley bottoms and adjacent valley side slopes. There are 63,770 acres in this association which are widely distributed throughout the central part of Mora County.

The La Brier series consists of deep, well drained soils formed in fine textured alluvium. They occur on the nearly level to very gently sloping terraces and side slopes.

The Manzano series consists of deep, well drained soils formed in alluvium along drainageways, valley floors, and lower parts of alluvial fans. They form on nearly level to gently sloping surfaces.

The Loma series consists of deep, well drained soils formed in calcareous eolian materials on mesas, hills, and ridges. Loma soils occupy the higher and more sloping portions in this association with nearly level to moderately sloping landscapes.

Other soils in this association include the Tricon, Bernal, Carnero, Torreon, Crews, and Vermejo series.

The major part of the irrigated cropland in Mora County is in this association. Alfalfa and other irrigated hay and pasture crops are the most extensively grown. The nonirrigated lands provide grazing for livestock and wildlife. In general, the soils are productive, but forage production varies considerably depending on the amount of moisture. Vegetation is dominated by mid and short grasses including blue grama, western wheatgrass, vine-mesquite, galleta, mat muhly, alkali sacaton, switchgrass, and some fringed sagewort, fourwing saltbush, and winterfat. A few cottonwood trees and shrubs also commonly occur on the floodplains contiguous to the larger streams.

This association has a high potential for expansion of irrigated land. There is 1 percent in this association in irrigation land class 1; 75 percent in class 2; 13 percent in class 3; 3 percent in class 4; and the remaining 8 percent in class 6 or nonirrigable.

Soil Association 35
Remunda-Stroupe, Crews Association

The soils in this association are extremely variable. They range from shallow to deep and formed dominantly in parent material weathered from sedimentary formations, including shale and interbedded sandstone, siltstone, and shale. In addition to the sedimentary materials, a veneer of gravelly alluvium covers the surface in many areas. This association, consisting of about 13,530 acres, occurs in the west central part of Mora County in the vicinity of Rainsville. It is mainly on gently to strongly sloping and rolling uplands.

The Remunda series are deep, well drained soils occuring on gently to moderately sloping valley side slopes and alluvial fans. The alluvial material is derived from red bed shales and siltstones.

Stroupe series are shallow, well drained soils which occur on strongly sloping and undulating terraces and valley slopes. These soils are gravelly and cobbly and formed in materials weathered from igneous and sandstone rocks.

Crews series are shallow, well drained soils formed in mixed materials on the sloping and undulating crest and moderately sloping sides of ridges and terraces.

Also included in this soil association are soils of the Loma, Carnero, and Bernal series. Gullied land and Rock outcrop also comprise small acreages in this association.

This association is used for livestock grazing and wildlife and has a fair to good cover of vegetation. The more common species of native vegetation include blue grama, muhly species, threeawn, fringed sagewort, and snakeweed.

Seventy-eight percent of this association is classified as irrigable, but it offers only limited opportunity for expansion of irrigation because the entire acreage is small and land classes 4 and 6 are intermingled with the land of high capability for irrigation. There is 44 percent of the land in this association in irrigation land class 2; 34 percent in class 4; and the remaining 22 percent is nonirrigable in class 6.

Soil Association 36
Bernal-Travessilla-Crews Association

The soils in this association are dominantly shallow, but moderate and deep soils are represented. These soils are on gently sloping to moderately steep and rolling uplands and are underlain by sandstone and indurated caliche. There are also some eolian and alluvium soils. There are about 325,070 acres in this association in the eastern and southern margins of Mora County and the north central part of San Miguel County.

Bernal series consist of shallow, well drained soils formed in material weathered from sandstone modified by eolian sediments. They occupy gently sloping and rolling landscapes.

Travessilla soils are shallow and well drained. They are on gently sloping to moderately steep landscapes and developed on sandstone mesas and breaks.

The Crews series are shallow, well drained soils formed in mixed materials. They are sloping and undulating crest and moderately sloping sides of ridges and terraces.

Soils of minor extent in this association are the Carnero, Berthoud, Remunda, Rednun, and Pastura.

Soils of this association are in native range. They support a relatively complex mixture of mid and short grasses, including such species as blue grama, sideoats grama, sand dropseed, galleta, and little bluestem. Thin stands of juniper and pinyon are also common on the Travessilla and Bernal soils and near the outer fringes of this unit.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

The potential for development for irrigated land in this association is extremely limited. The major and most extensive soils in this association are not suitable for irrigation because of their shallow depth and limited water-holding capacity. There is 5 percent of this association in irrigation land class 2; 4 percent in class 3; 11 percent in class 4; and 80 percent in class 6.

Soil Association 37
Apache-Capulin Association

These soils are dark-colored and generally shallow to moderately deep. The land surface on the tops of the mesas and lava flows is dominantly gently to strongly sloping but ranges from nearly level to moderately steep. The sides of the basalt-capped mesas and volcanic hills or plugs, as well as the fronts of lava flows, are steep to very steep. Included in this association are soils forming in materials of volcanic or basic igneous origin on old lava flows and basalt mesas in the central part of Mora County. It consists of a number of widely separated areas of approximately 70,640 acres. A characteristic feature of this unit is the stony and rocky nature of many of the soils.

The Apache series consists of very shallow and shallow, well drained soils formed in material weathered from basalt on basalt capped mesas and lava flows. They are on gently sloping to moderately sloping landscapes.

Capulin series are deep, well drained soils formed in eolian and alluvial materials and residuum from basalt. They are nearly level to gently sloping mesa tops.

Rock outcrop, a significant miscellaneous land type, occurs on steep and very steep escarpments, lava flow fronts, and isolated basalt hills or outcrops.

Also in this association are soils of the Cabezon, Thunderbird, and Torreon series.

This association is used for grazing livestock and wildlife, but stoniness, rockiness, and strong slopes tend to limit accessibility to domestic stock. It is dominated by grass vegetation, including blue grama, galleta, sand dropseed, western wheatgrass, sideoats grama, little bluestem, big bluestem, and threeawn. The more common shrubs and woody species are snakeweed, fourwing saltbush, oak, and scattered pinyon and juniper trees.

This association, which is dominated by stony and shallow soils, offers little opportunity for development of irrigated land. There is 3 percent of the association in irrigation land class 2, 38 percent in class 4, and the remaining 59 percent is nonirrigable in class 6.

Soil Association 38
Bond-Fortwingate Association

These soils, which are dominantly shallow to moderately deep, formed in materials weathered from sedimentary rocks consisting principally of sandstone. In addition to stones, which are common in many of the soils, sandstone bedrock outcrops occasionally on the steeper slopes. Steep mountainous landscapes with slope gradients of 15 to 60 percent or more are characteristic of this general soil area. Included in this association are 28,100 acres in the Turkey Mountain area of central Mora County.

Bond series are shallow, well drained soils formed in residuum from sandstone and usually occur on moderately steep to steep mountain slopes. A thin layer of decomposing forest litter usually covers the surface.

Fortwingate series consists of moderately deep, well drained soils that formed in material weathered from sandstone. They occupy strongly sloping to rolling crests and steep side slopes of ridges.

Other soils of importance in this association include the Loma, Carnero, and Bernal series. Rock outcrop makes up a small acreage in this association.

This association is suitable for varied uses, including recreation, livestock, and wildlife grazing, watershed area, and production of commercial timber. It supports good stands of native vegetation consisting of pinyon, juniper, ponderosa pine, oak, and mountainmohogany with an understory of cool-season grasses. The more common grasses are Arizona fescue, mountain muhly, mountain brome, little bluestem, big bluestem, blue grama, western wheatgrass, and sideoats grama.

This association, dominated by steep and mountain topography, offers little or no opportunity for development of irrigated land. Only 5 percent of the land is considered irrigable in irrigation land class 2, with the remaining 95 percent classified nonirrigable in class 6.

Soil Association 39
Rock outcrop-Encierro-Bernal Association

A wide variety of rocks are contributing to the parent materials in which the soils of this association are developing. Sandstone, shale, quartzite, schist, and gneiss are the more common types. These rock types often outcrop on the steep slopes and occur in a complex pattern with stony and shallow soils. The narrow valley floors and upland summits are commonly separated by steep escarpments, canyon walls, and steep side slopes. This association consists of about 62,250 acres along the east flank of the Sangre de Cristo Mountains in Mora and San Miguel Counties.

Approximately 40 percent of this association has been included in a land type identified as Rock outcrop. It includes those parts of this general soil area that are dominated by numerous outcrops of bedrock and that usually occur on steep to very steep slopes. It consists of a complex of outcrops and shallow soil with variable characteristics.

Encierro series is a shallow, well drained soil formed in materials weathered from sandstone and interbedded shale. They occur on strongly sloping to moderately steep and rolling ridgecrests and side slopes in this soil association.

Other soils comprising the remainder of the association include Travessilla, Deama, Mirabal, and Manzano soils.

These steep, mountainous and rocky lands support a wide variety of grasses, shrubs, and trees. The density of the vegetation in many parts of this association is restricted because of the steep slopes, thin soil, and rock outcrops. The vegetation consists of pinyon, juniper, ponderosa pine, oak, and various other shrubs with an understory of grasses. The dominant grasses are blue grama, Arizona fescue, sideoats grama, sleepygrass, western wheatgrass, and threeawn.

There is essentially no opportunity for developing irrigated land in this association. The dominance of shallow soils, together with rock outcrops, steep slopes, and rough topography, preclude the use of this land for irrigation.

Soil Association 40
Nambe-Cundiyo Association

This association consists of deep, well drained soils formed in materials weathered mostly from granite and quartzite and ranges from neutral to strongly acid in reaction. The land form pattern is long, steep slopes, crowned by relatively broad ridge tops. Slope gradients of 5 to 75 percent or more are characteristic of this general soil area. Included in this association is a high mountain area consisting of about 5,430 acres in the southwestern part of Mora County.

Nambe series consists of deep, well drained soils formed in colluvial-alluvial materials derived from granite, gniess and schist. They occupy steep to very steep mountain slopes.

Cundiyo series are deep, well drained, and excessively drained soils, and formed in alluvium from acid igneous rocks. They are on steep and very steep ridges and side slopes on granitic mountains.

The lesser soils in the association include Bobtail, Penitente, Lunch, Tampico, and some Rock outcrop.

Water and timber for scenic values are probably the most important resource products of this soil area. Typically, it supports a thick stand of Engelmann spruce, but at lower elevations, white fir, Douglas-fir, and aspen are prevalent. Kobresia, timberline bluegrass, shrubby cinquefoil, and carex species occur in the alpine areas.

This association has little or no potential for development of irrigated land. All the land in this association has been included in class 6.

Soil Association 41
Gaines-Hayspur Association

Included in this soil association are deep, dark-colored soils of high mountain valleys. The soils in the immediate valley bottoms are nearly level to gently sloping and are usually poorly drained. The well drained soils on the valley side slopes are gently to strongly sloping and are occasionally undulating. This association consists of about 19,420 acres including the valley and bottom lands adjacent to the Mora River in Mora County.

Gaines series are moderately deep, well drained soils formed in residuum from limestone on gently sloping to strongly sloping valley side slopes.

The Hayspur series consists of moderately deep, poorly drained soils formed in mixed alluvium on level to very gently undulating bottomlands.

Also included in this association is miscellaneous land type Rock outcrop.

The land in this association is used primarily for the production of irrigated hay and pasture and as rangeland. A few scattered tracts of land are also dry farmed, even though this is hazardous under the climatic conditions prevailing in this area. The native range area supports a good cover of vegetation, including such species as bluegrass, prairie, junegrass, sleepygrass, blue grama, mountain brome, red fescue, fringed sagewort, sage, timothy, and clover. Sedges, yarrow, and iris also occur, particularly on the bottoms where the soils are poorly drained.

Although this association contains a relatively high percentage of land classified suitable for irrigation, it offers only limited opportunity for irrigation expansion. Small acreages, wetness, and flood hazard are factors contributing to this relatively low potential. There is approximately 25 percent of the land in this association in class 2; 25 percent in class 3; 35 percent in class 4; and the remaining 15 percent is nonirrigable in class 6.

Soils Association 42
Vermejo-Remunda Association

The soils of this association, which are dominantly deep, developed on alluvium derived principally from sedimentary rocks consisting of shale, sandstone, and limestone. The soils in the immediate valley bottoms are somewhat poorly drained, and the water table may be encountered at depths of 6 to 7 feet or less during the growing season. The fine textured and poorly drained soils are slightly to moderately saline, but a small acreage in this association contains a high concentration of soluble salts. Included in this association are nearly level to gently sloping valley bottoms in adjacent gently to strongly sloping valley side slopes. This association is made up of about 18,870 acres in the westcentral part of Mora County and in the northcentral part of San Miguel County.

Vermejo series consists of deep, moderately well drained soils formed in alluvium from shale on the nearly level to gently sloping valley bottoms. They are slightly to moderately saline.

Remunda series are deep, well drained soils formed in mixed sediments of sedimentary and igneous origin. These are nearly level to gently sloping soils.

The Partri soils, while not named in this association, make up a significant part of the association. The series consists of deep, well drained soils formed in alluvium from limestone, sandstone and basalt on fans and plains.

The remainder of the association is made up of the Carnero, Colmor, Renohill, Midway, and Manzano series.

This association is used dominantly as hayland, pasture, and rangeland. It supports a good cover of vegetation, including alkali sacaton, western wheatgrass, blue grama, galleta, inland saltgrass, vine-mesquite, and Canada wildrye, switchgrass, and mat muhly. The inland saltgrass and alkali sacaton are more common on the poorly drained and saline soil.

Approximately 84 percent of the land in this association has been classified as suitable for irrigation. Much of the irrigable land, however, occurs in valley bottoms and low lying positions where it is subject to accumulation of salts and development of unfavorable drainage conditions. There is 3 percent in irrigation land class 1; 26 percent in class 2; 31 percent in class 3; 24 percent in class 4; and the remaining 16 percent is in class 6, nonirrigable.

Soils Association 43
Pullman-Mansker-Amarillo Association

This association is dominated by moderately deep and deep and well drained soils. They formed generally on parent material of the eolian origin deposited on the Ogallala Formation. The topography is smooth, nearly level to gently undulating with slopes usually averaging less than 2 percent. There are about 338,340 acres of this association in the southwestern and southern parts of Quay County and in the northern part of Curry County.

Pullman series are deep, well drained soils formed in calcareous clayey materials on nearly level to gently sloping uplands.

Mansker series consists of deep, well drained soils formed in calcareous, loamy eolian materials occurring on nearly level to gently sloping uplands. They are strongly calcareous.

Amarillo series consists of deep, well drained soils formed in calcareous loamy materials on nearly level to very gently sloping uplands.

About 5 percent of this association is made up of Church, Drake, Manwood, and Spur soils.

The soils of this association are used for dry farming and range. Winter wheat is a principal cash crop, but grain and forage sorghums and other small grains are also grown. Because of the semi-arid climate, farmers cannot rely on continuous high yields under dryland farming. Although much of this land is under cultivation, many areas of native pasture also occur. Blue grama is the dominant grass on the native pasture areas. Other grasses of lesser extent that are commonly associated with blue grama are buffalograss, galleta, tobosa, sideoats grama, spike muhly, and minor amounts of vine-mesquite, little bluestem, and western wheatgrass.

The soils of this unit, which are dominantly in irrigation land classes 1 and 2, have in general a high potential for use as cropland under irrigation. Approximately 20 percent of the land in this association is in irrigation land class 1; 60 percent in class 2; 10 percent in class 3; 4 percent in class 4, and the remaining 6 percent is in class 6, or is nonirrigable.

Soils Association 44
Mansker-Potter Association

Calcareous soils that are developed over relatively thick beds of caliche are dominant in this association. Although these soils normally occupy gently sloping to undulating landscapes, they occur on nearly level areas. This association consists of approximately 110,140 acres occurring on the High Plains in the southern part of Quay County and in scattered areas throughout the AWR portion of Curry County. It includes the larger playas. Generally, it includes the side slopes that grade toward the drainageways, as well as the shallow, calcareous soils on the upper margin of these slopes.

Mansker series consists of deep, well drained soils formed in calcareous, loamy eolian materials occurring on nearly level to gently sloping uplands. They are strongly calcareous.

Potter series consists of very shallow, well drained soils formed in caliche materials on the gently to moderately sloping crests and side slopes of upland ridges and knolls.

Approximately 42 percent of this association consists of a number of soils of lesser extent and small acreages of miscellaneous land types. The minor series that comprise the largest acreages are the Manwood-Pullman, Arch, Drake, Portales, and Church.

Most of this association is in range use. The native vegetation consists of a mixture of mid and short grasses with a scattered stand of shrubs. The more common grass species are blue grama, hairy grama, sideoats grama, sand dropseed, and little bluestem.

Some soils in this association have moderate to severe wind erosion hazard under cultivation. Good conservation management practices are essential to minimize wind erosion damage on soils with moderate hazard. Soils with high and severe hazard should not be cultivated.

Irrigation land classes 3 and 4 lands are relatively extensive in this association, and classes 1 and 2 make up about 19 percent of the area. Therefore, some opportunity exists for expansion of irrigated land in this association. About 2 percent of the land in this unit has been included in irrigation land class 1; 17 percent in class 2; 36 percent in class 3; 15 percent in class 4; and the remaining 30 percent in class 6.

Soils Association 45
Bascom-Potter-Olton Association

This association, made up of five areas, consists of approximately 59,630 acres, entirely within Quay County. Three areas are located southwest of Tucumcari near the center of the county and two are in the extreme northeastern part. A nearly level to gently sloping and undulating type of topography prevails throughout most of the association. The soils developed in calcareous alluvial and eolian materials, overlying caliche and alluvial sediments with a high lime content.

Bascom series consists of deep, well drained soils formed in mixed sediments with high carbonate content. They usually occur on undulating to gently rolling uplands.

The Potter series consists of very shallow, well drained soils that formed in caliche materials on gently sloping to moderately sloping crests and side slopes on upland ridges and knolls.

Olton series consists of deep, well drained soils that formed in calcareous loamy materials on nearly level to gently sloping uplands.

Soils of minor extent in this association include those of Amarillo, Springer, Ima, Quay, and Tucumcari series.

Although the dominant use is range, a limited acreage of the Olton soils is cultivated under dry farming. Winter wheat and grain sorghums are the principal crops produced. The areas not under cultivation will generally support a good cover of grass, and under good management, moderate yields of forage are obtained. The principal grasses are blue grama, hairy grama, galleta, sand dropseed, sideoats grama, black grama, New Mexico feathergrass, and threeawn. The more common shrubs are broom snakeweed, yucca, and some mesquite and various species of cacti.

The potential for development of irrigated land in this association is limited. Eighteen percent of the association is in irrigation land class 1; 3 percent is in class 2; 7 percent is in class 4; and the remaining 72 percent is nonirrigable.

Soils Association 46
Amarillo-Ima Association

These soils are generally deep, well drained, and have moderately coarse textured surface layers. The soils, which formed in materials dominantly of alluvial and eolian origin, occupy gently sloping and undulating landscapes. This general soil association of 85,920 acres is in the the east central part of Quay County.

Amarillo soils are deep, well drained, and formed in old upland eolian or alluvial materials. These soils are on nearly level to gently sloping landscapes.

Ima series consists of deep, well drained soils formed in moderately coarse textured sediments occurring on gently to strongly sloping and undulating fans and valley-filled slopes.

Bascom soils, a significant part of the association, are well drained and usually occur on undulating to gently rolling, low or slightly elevated ridges. The soils formed in moderately coarse to medium textured mixed sediment with high carbonate content.

Also included in this association are soils of the Springer, Brownfield, Gomez, Los Tanos, and Minneosa series.

The principal dryland crops are forage sorghums, grain sorghums, and broomcorn. The land in this association that is in range use supports fairly good stands of native vegetation, including blue grama, hairy grama, sideoats grama, black grama, sand dropseed, sand mulhy, little bluestem, galleta, New Mexico feathergrass, threeawn, and some yucca, broom snakeweed, and various species of cacti.

The soils are moderately well suited to dry farming, however, they are susceptible to wind erosion. Practices to minimize wind erosion damages will be necessary on cultivated lands.

Approximately 84 percent of the land in this association has been classified as suitable for irrigation. The irrigable land is nearly equally divided among classes 1 through 3, as about 33 percent is in land class 1; 27 percent in class 2; and 24 percent in class 3; the remaining 16 percent is nonirrigable in class 6.

Soils Association 47
Quay-Montoya-Lacita Association

These soils are dominantly deep and formed generally in medium to fine textured alluvium eroded from red-bed formations. Soils that are on gently sloping to moderately undulating topography with smooth, nearly level areas bordering the drainageways prevail throughout this unit. This type of topography, however, is broken by a number of small mesas, buttes, and hills. The slopes on the sides of these mesas, buttes, and hills are moderately steep to steep. This association has about 399,060 acres located north of the High Plains escarpment in the central and western parts of Quay County.

Quay soils are deep, well drained, and are formed in alluvium from red bed sandstone and shale. They are on nearly level to gently sloping surfaces extending from the bases of escarpments and breaks to the lower lying valleys.

Montoya series consists of deep, well drained soils formed in fine textured calcareous sediments derived from red beds. They occur on slightly depressional to broad channeled floodplains.

Lacita soils are deep, well drained, and formed in silty calcareous alluvium. They occur dominantly on nearly level to gently sloping channelled valley bottoms and alluvial fans.

The remaining area of the association includes Ima, Tucumcari, La Lande, Redona, Canez, Kinkead, Toyah, and San Jon.

Much of the land now under irrigation in Quay County is in this association or in the sandy lands in the northern part of the Tucumcari area. Alfalfa, grain and forage sorghums, cotton, and small grains are the principal crops produced. The dominant use of soils in this association, however, is for livestock grazing. The principal grasses on the loam and clay loam soils are alkali sacaton, tobosa, blue grama, switchgrass, and vine-mesquite. Blue grama, sideoats grama, little bluestem, and sand dropseed are common on the sandy soils. Some pinyon and juniper trees occur on the outer fringes where this unit joins the escarpment area.

Although 92 percent of the land in this association has been classified as suitable for irrigation, it varies considerably in its capability for irrigation. Approximately 1 percent of the land has been placed in irrigation class 1; 44 percent in class 2; 38 percent in class 3; 9 percent in class 4; and the remaining 8 percent in class 6.

Soils Association 48
Ima-Tucumcari Association

This association is moderately deep to deep and developed in moderately coarse to moderately fine to fine textured alluvial sediments originating from red-bed formations. This association occurs on fans and valley-filling slopes below the High Plains escarpment in the eastcentral part of Quay County. A gently to moderately sloping topography with smooth, nearly level areas bordering the drainageways prevails throughout this unit. This association makes up an area of about 57,250 acres in Quay County.

Ima series consists of deep, well drained soils formed in moderately coarse textured sediments occurring on gently to strongly sloping and undulating fans and valley-filled slopes.

Tucumcari series consists of deep, well drained soils formed in moderately fine to fine textured alluvium on nearly level to very gently sloping alluvial fans and valleyside slopes.

About 25 percent of the association is made up of Lacita, La Lande, Redona, Kinkead, Los Tanos, and Bascom soils.

The dominant use of the soils in this association is for livestock grazing. The vegetation on the soils of this unit is quite variable. The more common grasses on the loam, silt loam, and clay loam soils type include alkali sacaton, tobosa, blue grama, switchgrass, and vine-mesquite. Blue grama, sideoats grama, sand dropseed, and some little bluestem are dominant on the sandy soils.

Although 89 percent of the land in this association has been classified as suitable for irrigation, it offers only a fair or limited potential for expansion of irrigation. Approximately 9 percent of the land in this association has been placed in irrigation land class 2; 80 percent in class 3; and the remaining 11 percent has been classified as nonirrigable.

Soils Association 49
Redona, Canez Association

The soils of this association are moderately deep to deep and developed in parent materials dominantly of alluvial and eolian origin. They occupy gently sloping and undulating landscapes. This association has about 157,330 acres in a number of widely separated areas in the north central part of Quay County.

Redona soils, the most extensive in this association, are deep, well drained, and formed in sediments derived from calcareous sandstone and shale of red-bed formations. Redona soils occupy smooth, nearly level to gently sloping landscapes.

The Canez series consists of deep, well drained soils formed in moderately coarse textured alluvium and eolian sediments on alluvial fans. They are on nearly level to gently sloping landscapes.

Quay soils, a significant part of the association, are deep, well drained, and occur mainly on gently sloping fans extending from the bases of escarpments and breaks to the lower-lying valleys. They are formed in moderately fine textured alluvium derived from sandstone and shale.

About 30 percent of the association includes Ima, Tucumcari, Bascom, Gallegos, San Jose, and Montoya series.

The soils not under cultivation generally support fair to good stands of native vegetation consisting of black grama, blue grama, hairy grama, sideoats grama, sand dropseed, buffalograss, tobosa, sand mulhy, New Mexico feathergrass, threeawn, yucca, broom snakeweed, and some mesquite, sand sagebrush, and cholla cactus.

The major soils in this association are well suited as irrigated cropland. Approximately 5 percent of the land in this general soil area has been placed in irrigation land class 1; 74 percent in class 2; 15 percent in class 3; and the remaining 6 percent in nonirrigable or in class 6.

Soils Association 50
Lacita-La Llande-Quay association

These soils are moderately deep to deep, formed on gently sloping and undulating topography and developed in parent material dominantly of alluvial sediments derived from red-bed formations including sandstone, shale, and siltstone. Included in this association is an area of 87,250 acres in southeastern Quay County.

Lacita soils are deep, well drained, and formed in silty calcareous alluvium. They occur dominantly on nearly level to gently sloping channeled valley bottoms and alluvial fans.

La Lande soils are deep, well drained, and formed in moderately fine textured calcareous sediments derived from red beds. They occur dominantly on nearly level to moderately sloping alluvial fans and piedmont slopes.

Quay soils are deep, well drained, and occur mainly on sands and valley-filling slopes extending from the bases of escarpments and breaks to the lower lying valleys. The Quay soils are on nearly level to gently sloping landscapes.

About 33 percent of the association includes gullied land, and soils of Ima, Tucumcari, Kinkead, San Jose, Gallegos, Los Tanos, Redona, and Bascom series.

Most of these soils are moderately deep to deep and support fair to good stands of both mid and short grass types. The more common grasses are blue grama, black grama, hairy grama, sideoats grama, threeawn, tobosa, alkali sacaton, switchgrass, vine-mesquite and sand dropseed. Mesquite, yucca, snakeweed, and fourwing saltbush are the more prevalent shrubs, with some juniper.

This association is dominated by irrigation land classes 2 and 3 and offers a fair potential for expansion or irrigation. Slope, unevenness of the land surface, susceptibility to overflow, and erosion were the principal factors contributing to the placement of the soils in these land classes. There is 41 percent of this association in irrigation land class 2; 40 percent in class 3; 1 percent in class 4; and the remaining 18 percent is nonirrigable class 6.

Soils Association 51
Latom-Rock outcrop Association

These soils, which are generally shallow, formed residually in parent materials of sandstone origin. Thin deposits of gravelly alluvium and sandy eolian deposits occur locally. Although it is characterized by moderately steep to rolling and hilly topography, small areas of valley bottoms, alluvian fans and other tracts of land on nearly level to gently sloping landscapes are included. This association has 97,500 acres in northwestern Quay County and is locally known as the "Palomas Hills."

The Latom series consists of shallow, well drained soils formed in materials weathered from sandstone on gently to strongly sloping uplands.

Latom-Rock outcrop complex differs primarily from Latom's stony sandy loam in that it contains numerous outcrops of sandstone bedrock and occupies steep and hilly landscapes. The outcrops of bedrock that occur in a complex pattern in Latom's sandy loam usually consist of nearly vertical exposures and ledges. Small isolated pockets of moderately deep to deep soils do occur on the steep breaks with benches or areas of lesser slope gradient.

About 15 percent of this association includes soils of the Gallegos, Ima, and Quay series.

This unit generally supports thin stands of pinyon and juniper. Other shrubs include mesquite, shrub live oak, skunkbush sumac, rabbitbrush, sagebrush, and an occasional yucca. Short and mid grasses, however, are the more common ground cover. The principal grasses include blue grama, black grama, sideoats grama, galleta, tobosa, little bluestem, and threeawn.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

There is very little, if any, potential for the development of irrigated land in this association. The steep slopes and shallow soils will tend to limit its use for agriculture. Approximately 93 percent of the land in this general soil area has been classified as not suitable for irrigation. There is 3 percent in irrigation land class 2; 3 percent in class 3; and 1 percent in class 4.

Soils Association 52
Tucumcari-Montoya Association

These soils are dominantly deep and developed mainly in alluvial sediments from red-bed formations including shale, siltstone, and sandstone. The topography ranges from nearly level or very gently sloping in the valley bottoms, to gently sloping and undulating in the valley-filling slopes. It occurs in the valley areas and in the valley-filling slopes below the Las Vegas Plateau. There are 5040 acres of this association in eastern San Miguel County.

Tucumcari series consists of deep, well drained soils formed in moderately fine to fine textured alluvium on nearly level to very gently sloping alluvial fans and valley-side slopes.

Montoya series consists of deep, well drained soils formed in fine textured calcareous sediments derived from red beds, occurring on broad channeled floodplains and adjacent alluvial fans and piedmont slopes. The series is on slightly depressional to moderately sloping landscapes.

Redona soils, also significant in the association, are deep, well drained, and occupy the nearly level to very gently undulating plains. They are formed in moderately fine textured calcareous sediments derived from sandstone and shale.

Other soils and land types in the association are made up of gullied land and soils of the Mesita, Quay, and Alama series.

These soils generally support fair to good stands of native vegetation. The more common grasses are galleta, alkali sacaton, blue grama, hairy grama, vine-mesquite, and inland saltgrass.

This association offers only a limited opportunity for development of irrigated land because of its small size. In addition, many of the soils classified as irrigable have moderate to severe limitations for use as irrigated cropland. Five percent of the land in this association is in irrigation land class 1; 29 percent is in class 2; 48 percent is in class 3; 10 percent is in class 4; and the remaining 8 percent is nonirrigable or in class 6.

Soils Association 53
Carnero-Rednun-Bernal Association

These soils, which range from shallow to deep, formed on gently to strongly sloping and rolling uplands. Although the soils are variable in depth, this association contains extensive areas of moderately deep and deep soils. This association has 104,550 acres occurs in north central San Miguel County on the Las Vegas Plateau. A few small delineations are also included on the uplands on the northeastern part of the county.

Carnero series consists of moderately deep, well drained soils formed in mixed eolian sediments and residuum from sandstone. They occupy gently sloping and undulating uplands.

The Rednun series are deep, well drained soils formed in calcareous alluvial fan sediments which occupy the nearly level to gently sloping landscapes in this association.

Bernal series consists of shallow, well drained soils formed in material weathered from sandstone modified by eolian sediments. They occupy gently sloping and rolling landscapes.

Soils making up the remaining 40 percent of this association include those of the Travessilla, Penrose, Reno Hill, Litle, and Rudd series.

These soils are used for grazing of livestock and wildlife and to a very limited extent, for irrigated farming. Blue grama, sideoats grama, little bluestem, ring mulhy, sand dropseed, galleta, and threeawn are the more common grasses. Thin to moderate stands of pinyon and juniper trees are also scattered throughout this association.

Calculated rates indicate soils in this association have moderately high erosion. Some soils are highly susceptible to erosion when the vegetative cover is reduced or destroyed by grazing or farming. Good conservation management is needed on the soils to prevent excessive erosion.

Although this association contains a relatively high percentage of nonirrigable land, there is some potential for expansion of irrigation. There is 16 percent of the land in this association placed in irrigation land class 1; 4 percent in class 2; approximately 35 percent in class 4; and the remaining 45 percent of the land is nonirrigable class 6.

Soil Association 54
Chimayo-Mirabal-Supervisor Association

These soils, which are generally shallow to moderately deep, developed dominantly in materials weathered from granite, gneiss, and schist. The surface soils are usually gravelly or stony and range in reaction from neutral to slightly acid. They occupy steep to very steep mountain landscapes with slope gradients that generally range from about 50 to 70 percent or more. This association is made up of an area of about 11,260 acres in northwestern San Miguel County.

Chimayo series consists of shallow, well drained soils formed in material weathered from gneiss, granite-gneiss, and interbedded schist. The Chimayo series is nearly level to very steep slopes on foothills and lower mountain sides.

The Mirabal series consists of moderately deep, well drained soils formed in material weathered from acid igneous rocks. They are on moderately sloping to extremely steep landscapes on mountain slopes.

Supervisor series consists of moderately deep, well drained soils formed in material weathered from granite, gneiss, and schist on mountain slopes. They have moderately sloping to extremely steep landscapes.

The remaining 40 percent of this association are small areas of unnamed alluvial soil sand miscellaneous land types. Rock outcrop, which consists of a complex of a very shallow soil and outcrops of granite, schist, and gneiss, is the dominant land type.

This association is used for timber production, range, and recreation. The major soils in this unit in general support good stands of native vegetation. The principal trees in the higher elevations of the association are ponderosa pine, Engelmann spruce, white, and Douglas fir, and traces of aspen. Trees in the lower elevations are pinyon, juniper, and some oak. The principal grasses are western wheatgrass, sideoats grama, little bluestem, mountain brome, Arizona fescue, galleta, blue grama and dropseed.

There is essentially no potential for the development of irrigated land in this association. The only soil with property suitable for irrigation are the small areas of deep alluvial soils. The small size, location, and isolated nature of these irrigable lands will generally preclude their use for this purpose.

TABLE C-1--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Lacita-Redona-Quay association	504,840	4.4
3	San Jon-Los Tanos-Ima association	63,030	0.6
4	Conchas-Latom association	509,210	4.4
5	Redona-Bascom association	24,660	0.2
6	Rock outcrop-Orthents-Ustolls association	801,130	7.1
7	Gruver-La Brier-Dumas association	735,940	6.5
8	Litle-Berthoud-Penrose association	53,100	0.5
9	Berthoud-Kinkead association	92,550	0.8
10	Church-Karde association	19,540	0.2
11	Campus-Dean association	166,650	1.5
12	Mansker-Portales association	34,310	0.3
13	Otero-Dalhart association	36,280	0.3
14	Amarillo-Springer association	296,730	2.6
15	Springer-Tivoli-Amarillo association	361,810	3.2
16	Apache-Torreon-Tricon association	717,210	6.3
17	Travessilla-Carnero-Rock outcrop association	944,130	8.3
18	Gallegos association	38,460	0.3
19	Spurlock-Texline association	340,970	3.0
20	Colmor-Litle association	64,400	0.6
21	Dallam-Rickmore association	336,020	3.0
22	Manzano-Alicia association	91,710	0.8
23	Aridic argiustolls-Rock outcrop association	190,300	1.7
24	Colmor-Swastika association	557,520	4.9
25	Mion-Vermejo-Litle association	418,240	3.7
26	Raton-Barela association	92,920	0.8
27	Morval-Moreno-Brycan association	57,410	0.5
28	Bundo-Angostura-Tolby association	172,800	1.5
29	Burnac-Fuera-Hillery association	133,400	1.2
30	Etoe-Etown-Angostura association	131,930	1.2
31	Dargol-Fuera-Vamer association	735,070	6.5
32	Torreon-Thunderbird-Crews association	173,560	1.5
33	Rednun-Carnero-Tricon association	325,900	2.9
34	La Brier-Manzano-Loma association	63,770	0.6
35	Remunda-Stroupe-Crews association	13,530	0.1
36	Bernal-Travessilla-Crews association	325,070	2.9
37	Apache-Capulin association	70,640	0.6
38	Bond-Fortwingate association	28,100	0.2
39	Rock outcrop-Encierro-Bernal association	62,250	0.5
40	Nambe-Cundiyo association	5,430	*
41	Gaines-Hayspur association	19,420	0.2
42	Vermejo-Remunda association	18,870	0.2
43	Pullman-Mansker-Amarillo association	338,340	3.0
44	Mansker-Potter association	110,140	1.0
45	Bascom-Potter-Olton association	59,630	0.5
46	Amarillo-Ima association	85,920	0.8
47	Quay-Montoya-Lacita association	399,060	3.5
48	Ima-Tucumcari association	57,250	0.5
49	Redona-Canez association	157,330	1.4
50	Lacita-La Lande-Quay association	87,250	0.8
51	Latom-Rock outcrop association	97,500	0.9
52	Tucumcari-Montoya association	5,040	*
53	Carnero-Rednun-Bernal association	104,550	0.9
54	Chimayo-Mirabal-Supervisor association	11,260	0.1
	Total	11,342,080	100.0

* Less than 0.1 percent.

TABLE C.2-CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Alicia	Fine-silty, mixed, mesic Ustollic Camborthids
Amarillo	Fine-loamy, mixed, thermic Aridic Paleustalfs
Angostura	Loamy-skeletal, mixed Typic Cryoboralfs
Apache	Loamy, mixed, mesic Lithic Haplustolls
Barela	Fine, mixed Typic Argiborolls
Bascom	Loamy-skeletal, carbonatic, thermic Ustollic Calciorthids
Bernal	Loamy, mixed, mesic Lithic Argiustolls
Berthoud	Fine-loamy, mixed, mesic Aridic Ustochrepts
Bond	Loamy, mixed, mesic Lithic Ustollic Haplargids
Brycan	Fine-loamy, mixed Cumulic Haploborolls
Bundo	Loamy-skeletal, mixed Typic Paleboralfs
Burnac	Fine, montmorillonitic Mollic Eutroboralfs
Campus	Fine-loamy, mixed, mesic Typic Calciustolls
Canez	Fine-loamy, mixed, thermic Ustollic Haplargids
Capulin	Fine-loamy, mixed, mesic Aridic Argiustolls
Carnero	Fine, mixed, mesic Aridic Argiustolls
Chimayo	Loamy-skeletal, mixed, nonacid, mesic Lithic Ustorthents
Church	Fine, mixed, mesic Aquic Camborthids
Colmor	Fine-silty, mixed, mesic Torriorthentic Haplustolls
Conchas	Fine-silty, mixed, thermic Ustollic Calciorthids
Crews	Clayey, mixed, mesic, shallow Petrocalcic Paleustolls
Cundiyo	Loamy-skeletal, mixed Typic Cryoboralfs
Dalhart	Fine-loamy, mixed, mesic Aridic Haplustalfs
Dallam	Fine-loamy, mixed, mesic Aridic Paleustalfs
Dargol	Fine, mixed Typic Eutroboralfs
Dean	Fine-loamy, carbonatic, mesic Ustollic Calciorthids
Dumas	Fine-loamy, mixed, mesic Aridic Paleustolls
Encierro	Clayey, mixed, mesic Lithic Argiustolls
Etoe	Loamy-skeletal, mixed Typic Paleboralfs
Etown	Clayey-skeletal, mixed Typic Paleboralfs
Fortwingate	Fine, montmorillonitic Typic Eutroboralfs
Fuera	Fine, mixed Typic Eutroboralfs
Gaines	Fine, mixed Pachic Argiborolls
Gallegos	Loamy-skeletal, mixed, thermic Ustollic Camborthids
Gruver	Fine, mixed, mesic Aridic Paleustolls
Hayspur	Fine-loamy, mixed, frigid Fluvaquentic Haplaquolls
Hillery	Fine, montmorillonitic Pachic Argiborolls
Ima	Coarse-loamy, mixed, thermic Ustochreptic Camborthids
Karde	Fine-silty, carbonatic, mesic Ustic Torriorthents
Kinkead	Fine, mixed, thermic Aridic Argiustolls
La Brier	Fine, mixed, mesic Torrertic Argiustolls
La Lande	Fine-loamy, mixed, thermic Ustollic Camborthids
Lacita	Fine-silty, mixed (calcareous), thermic Ustic Torriorthents
Latom	Loamy, mixed (calcareous), thermic Lithic Ustic Torriorthents
Litle	Fine, mixed, mesic Ustollic Camborthids
Loma	Fine, montmorillonitic, mesic Aridic Argiustolls
Los Tanos	Coarse-loamy, mixed, thermic Ustochreptic Camborthids
Mansker	Fine-loamy, carbonatic, thermic Calciorthidic Paleustolls
Manzano	Fine-loamy, mixed, mesic Cumulic Haplustolls
Mion	Clayey, mixed (calcareous), mesic, shallow Ustic Torriorthents
Mirabal	Loamy-skeletal, mixed, nonacid, frigid Typic Ustorthents
Montoya	Fine, mixed, thermic Mollic Torrerts
Moreno	Fine, mixed Typic Argiborolls
Morval	Fine-loamy, mixed Aridic Argiborolls
Nambe	Loamy-skeletal, mixed Typic Cryochrepts
Olton	Fine, mixed, thermic Aridic Paleustolls
Otero	Coarse-loamy, mixed (calcareous), mesic Ustic Torriorthents
Penrose	Loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents
Portales	Fine-loamy, mixed, thermic Aridic Calciustolls
Potter	Loamy, carbonatic, thermic, shallow Ustollic Calciorthids
Pullman	Fine, mixed, thermic Torrertic Paleustolls
Quay	Fine-silty, mixed, thermic Ustochreptic Calciorthids
Raton	Clayey-skeletal, mixed Lithic Argiborolls
Rednun	Fine, montmorillonitic, mesic Aridic Argiustolls
Redona	Fine-loamy, mixed, thermic Ustollic Haplargids
Remunda	Fine, mixed, mesic Aridic Argiustolls
Rickmore	Fine-loamy, mixed, mesic Aridic Paleustalfs
San Jon	Fine-loamy, mixed, thermic Ustochreptic Calciorthids
Springer	Coarse-loamy, mixed, thermic Udic Paleustalfs
Spurlock	Coarse-loamy, carbonatic, mesic Calciorthidic Paleustalfs

TABLE C.2 -CLASSIFICATION OF THE SOILS--Continued

Soil name	Family or higher taxonomic class
Stroupe	Clayey-skeletal, mixed, mesic Aridic Argiustolls
Supervisor	Loamy-skeletal, mixed Typic Cryoborolls
Swastika	Fine, mixed, mesic Aridic Argiustolls
Texline	Fine-loamy, mixed, mesic Calciorthidic Paleustolls
Thunderbird	Fine, montmorillonitic, mesic Aridic Argiustolls
Tivoli	Mixed, thermic Typic Ustipsamments
Tolby	Sandy-skeletal, mixed Typic Cryochrepts
Torreon	Fine, montmorillonitic, mesic Aridic Argiustolls
Travessilla	Loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents
Tricon	Fine, mixed, mesic Petrocalcic Paleustolls
Tucumcari	Fine, mixed, thermic Ustollic Haplargids
Vamer	Clayey, mixed Lithic Eutroboralfs
Vermejo	Fine, mixed (calcareous), mesic Ustic Torriorthents
Vingo	Coarse-loamy, mixed, mesic aridic paleustalfs

TABLE C-3 -PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydro-logic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
2*:											
Lacita----------	0-8	15-25	0.2-0.6	0.19-0.21	7.9-8.4	<2	Low----------	0.49	5	4L	B
	8-72	20-35	0.2-0.6	0.19-0.21	7.9-8.4	<2	Moderate-----	0.49			
Redona----------	0-10	10-15	0.6-2.0	0.12-0.15	7.4-7.8	<2	Low----------	0.24	5	3	B
	10-60	20-35	0.6-2.0	0.14-0.21	7.4-8.4	<2	Moderate-----	0.32			
Quay------------	0-9	10-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low----------	0.37	5	4L	B
	9-26	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
	26-60	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.37			
3*:											
San Jon---------	0-8	18-27	0.6-2.0	0.14-0.16	7.4-9.0	<2	Low----------	0.37	3	4L	B
	8-12	28-35	0.2-0.6	0.10-0.13	7.4-9.0	<2	Moderate-----	0.28			
	12-26	24-35	0.2-0.6	0.13-0.15	7.4-9.0	<2	Moderate-----	0.32			
	26	---	---	---	---	---	-------------	----			
Los Tanos-------	0-6	8-17	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low----------	0.24	2	3	B
	6-24	8-18	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.28			
	24	---	---	---	---	---	-------------	----			
Ima-------------	0-10	5-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.37	5	3	B
	10-40	8-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.43			
	40-60	8-18	2.0-6.0	0.11-0.17	7.9-8.4	<2	Low----------	0.43			
4*:											
Conchas---------	0-5	12-25	0.6-2.0	0.16-0.21	7.4-8.4	<2	Low----------	0.37	2	5	C
	5-30	22-35	0.2-0.6	0.19-0.21	7.9-9.0	<2	Moderate-----	0.49			
	30	---	---	---	---	---	-------------	----			
Latom-----------	0-8	5-18	0.6-2.0	0.10-0.13	7.9-8.4	<2	Low----------	0.24	1	8	D
	8	---	---	---	---	---	-------------	----			
Quay------------	0-9	10-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low----------	0.37	5	4L	B
	9-26	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
	26-60	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.37			
5*:											
Redona----------	0-10	10-15	0.6-2.0	0.12-0.15	7.4-7.8	<2	Low----------	0.24	5	3	B
	10-60	20-35	0.6-2.0	0.14-0.21	7.4-8.4	<2	Moderate-----	0.32			
Bascom----------	0-16	10-20	2.0-6.0	0.13-0.17	7.9-8.4	<2	Low----------	0.32	2	3	B
	16-36	10-25	2.0-6.0	0.04-0.08	8.5-9.0	2-4	Low----------	0.20			
	36-72	10-20	2.0-6.0	0.12-0.16	8.5-9.0	2-4	Low----------	0.37			
Canez-----------	0-8	5-15	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low----------	0.32	5	3	B
	8-48	18-25	0.6-2.0	0.12-0.16	6.6-8.4	<2	Low----------	0.32			
	48-67	18-25	0.6-2.0	0.12-0.16	7.9-8.4	<2	Low----------	0.32			
6*:											
Rock outcrop.											
Orthents.											
Ustolls.											
7*:											
Gruver----------	0-8	15-35	0.6-2.0	0.15-0.20	6.6-7.8	<2	Moderate-----	0.32	5	6	C
	8-52	35-40	0.2-0.6	0.15-0.20	7.4-8.4	<2	Moderate-----	0.32			
	52-80	35-40	0.2-0.6	0.10-0.16	7.9-8.4	<2	Moderate-----	0.32			

See footnote at end of table.

TABLE C-3-PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydrologic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
7*:											
La Brier	0-13	27-35	0.2-0.6	0.19-0.21	6.6-8.4	<2	Moderate	0.32	5	7	C
	13-49	35-60	<0.06	0.16-0.20	7.4-8.4	<2	High	0.32			
	49-77	30-40	0.06-0.2	0.19-0.21	7.9-8.4	<2	Moderate	0.37			
Dumas	0-7	15-30	0.6-2.0	0.14-0.19	6.6-7.8	<2	Low	0.32	5	5	B
	7-34	22-35	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low	0.32			
	34-80	22-35	0.6-2.0	0.10-0.16	7.4-8.4	<2	Low	0.32			
8*:											
Litle	0-3	30-40	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.37	3	4L	D
	3-22	38-55	<0.06	0.14-0.19	7.9-8.4	2-8	High	0.32			
	22	---	---	---	---	---	---	---			
Berthoud	0-8	15-30	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low	0.37	5	5	B
	8-56	18-30	0.6-2.0	0.12-0.20	7.4-8.4	<2	Low	0.37			
Penrose	0-12	15-27	0.6-2.0	0.14-0.16	7.9-8.4	<2	Low	0.17	1	8	D
	12	---	---	---	---	---	---	---			
9*:											
Berthoud	0-8	15-30	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low	0.37	5	5	B
	8-56	18-30	0.6-2.0	0.12-0.20	7.4-8.4	<2	Low	0.37			
Kinkead	0-7	30-40	0.2-0.6	0.19-0.21	6.6-7.8	<2	Moderate	0.32	5	6	C
	7-42	35-50	0.06-0.2	0.14-0.16	6.6-8.4	<2	High	0.28			
	42-55	25-35	0.6-2.0	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
10*:											
Church	0-7	30-40	0.06-0.2	0.19-0.21	7.9-8.4	4-15	Moderate	0.28	5	4L	D
	7-60	38-52	<0.06	0.14-0.19	7.9-9.0	4-15	High	0.32			
Karde	0-11	15-25	0.6-2.0	0.13-0.17	7.9-8.4	2-8	Low	0.37	5	4L	B
	11-60	20-35	0.6-2.0	0.13-0.17	7.9-8.4	2-8	Low	0.37			
11*:											
Campus	0-8	18-35	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low	0.28	4	4L	B
	8-16	18-35	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.28			
	16-30	18-35	0.6-2.0	0.15-0.19	7.9-8.4	<2	Low	0.28			
	30	---	---	---	---	---	---	---			
Dean	0-7	10-25	0.6-2.0	0.11-0.15	7.9-8.4	<2	Low	0.28	1	4L	C
	7-60	18-25	0.06-0.2	0.04-0.06	7.9-8.4	2-4	Low	0.28			
12*:											
Mansker	0-12	10-20	2.0-6.0	0.12-0.14	7.9-8.4	<2	Low	0.34	3	3	B
	12-28	20-35	0.6-2.0	0.08-0.16	7.9-8.4	<2	Low	0.28			
	28-66	15-40	0.6-2.0	0.10-0.18	7.9-8.4	<2	Low	0.28			
Portales	0-8	10-17	0.6-2.0	0.13-0.15	7.4-8.4	<2	Low	0.37	5	3	B
	8-80	18-35	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.34			
13*:											
Otero	0-14	5-10	6.0-20	0.09-0.11	7.4-8.4	<2	Low	0.15	5	2	B
	14-60	10-20	6.0-20	0.08-0.12	7.4-8.4	<4	Low	0.17			
Dalhart	0-9	10-18	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low	0.24	5	3	B
	9-38	18-30	0.6-2.0	0.14-0.18	7.4-8.4	<2	Low	0.32			
	38-72	10-24	2.0-6.0	0.12-0.16	7.9-8.4	<2	Low	0.32			
14*:											
Amarillo	0-11	5-15	2.0-6.0	0.06-0.10	6.6-7.8	<2	Very low	0.15	5	2	B
	11-38	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Low	0.32			
	38-80	20-35	0.6-2.0	0.10-0.15	7.9-8.4	<2	Low	0.32			

See footnote at end of table.

TABLE C-3 -PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydrologic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
14*:											
Springer--------	0-16	5-15	6.0-20	0.06-0.10	6.6-7.8	<2	Very low-----	0.17	5	2	B
	16-42	10-18	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low----------	0.20			
	42-56	5-15	6.0-20	0.06-0.10	6.6-8.4	<2	Very low-----	0.20			
	56-80	10-25	0.6-6.0	0.10-0.16	6.6-8.4	<2	Low----------	0.20			
Brownfield------	0-26	3-10	6.0-20	0.03-0.08	6.6-7.8	<2	Very low-----	0.17	5	1	A
	26-80	20-35	0.6-2.0	0.12-0.18	6.6-8.4	<2	Low----------	0.24			
15*:											
Springer--------	0-16	5-15	6.0-20	0.06-0.10	6.6-7.8	<2	Very low-----	0.17	5	2	B
	16-42	10-18	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low----------	0.20			
	42-56	5-15	6.0-20	0.06-0.10	6.6-8.4	<2	Very low-----	0.20			
	56-80	10-25	0.6-6.0	0.10-0.16	6.6-8.4	<2	Low----------	0.20			
Tivoli----------	0-7	1-10	6.0-20.0	0.02-0.08	6.1-7.8	<2	Low----------	0.17	5	1	A
	7-60	1-10	6.0-20.0	0.02-0.08	6.1-8.4	<2	Low----------	0.17			
Amarillo--------	0-11	5-15	2.0-6.0	0.06-0.10	6.6-7.8	<2	Very low-----	0.15	5	2	B
	11-38	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Low----------	0.32			
	38-80	20-35	0.6-2.0	0.10-0.15	7.9-8.4	<2	Low----------	0.32			
16*:											
Apache----------	0-16	25-35	0.6-2.0	0.12-0.16	7.4-8.4	<2	Low----------	0.28	1	8	D
	16	---	---	---	---	---	-------------	----			
Torreon---------	0-6	14-22	0.6-2.0	0.16-0.21	6.6-7.3	<2	Low----------	0.28	5	6	C
	6-12	35-40	0.2-0.6	0.19-0.21	6.6-7.8	<2	High---------	0.24			
	12-40	40-55	0.06-0.2	0.14-0.18	6.6-7.8	<2	High---------	0.24			
	40-60	35-40	0.2-0.6	0.16-0.21	7.4-8.4	<2	High---------	0.24			
	60	---	---	---	---	---	-------------	----			
Tricon----------	0-7	20-27	0.2-2.0	0.19-0.21	6.6-7.8	<2	Low----------	0.32	2	6	C
	7-33	35-50	0.06-0.2	0.14-0.21	6.6-8.4	<2	High---------	0.28			
	33-39	20-35	0.2-0.6	0.13-0.15	6.6-8.4	<2	Moderate-----	0.28			
	39	---	---	---	---	---	-------------	----			
17*:											
Travessilla-----	0-4	10-18	0.6-2.0	0.09-0.12	6.6-8.4	<2	Low----------	0.32	1	5	D
	4-8	10-18	0.6-2.0	0.13-0.15	6.6-8.4	<2	Low----------	0.32			
	8	---	---	---	---	---	-------------	----			
Carnero---------	0-9	20-27	0.2-0.6	0.17-0.19	6.6-7.8	<2	Low----------	0.24	2	6	C
	9-28	35-50	0.06-0.2	0.13-0.20	6.6-8.4	<2	High---------	0.24			
	28	---	---	---	---	---	-------------	----			
Rock outcrop.											
18*:											
Gallegos--------	0-3	10-20	2.0-6.0	0.07-0.13	6.6-8.4	<2	Low----------	0.20	2	7	B
	3-21	20-30	2.0-6.0	0.04-0.10	7.4-8.4	<2	Low----------	0.10			
	21-60	0-15	6.0-20	0.03-0.05	7.9-8.4	<2	Low----------	0.10			
Gallegos--------	0-3	10-20	2.0-6.0	0.07-0.13	6.6-8.4	<2	Low----------	0.20	2	7	B
	3-21	20-30	2.0-6.0	0.04-0.10	7.4-8.4	<2	Low----------	0.10			
	21-60	0-15	6.0-20	0.03-0.05	7.9-8.4	<2	Low----------	0.10			
Gallegos--------	0-3	10-20	2.0-6.0	0.07-0.13	6.6-8.4	<2	Low----------	0.20	2	7	B
	3-21	20-30	2.0-6.0	0.04-0.10	7.4-8.4	<2	Low----------	0.10			
	21-60	0-15	6.0-20	0.03-0.05	7.9-8.4	<2	Low----------	0.10			
19*:											
Spurlock--------	0-7	15-30	0.6-2.0	0.13-0.17	7.9-8.4	<2	Low----------	0.28	5	4L	B
	7-60	27-32	0.6-2.0	0.10-0.16	7.9-8.4	<2	Low----------	0.32			
	60-80	27-32	0.6-2.0	0.14-0.19	7.9-8.4	<2	Low----------	0.32			

See footnote at end of table.

TABLE C-3-PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydrologic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
19*:											
Texline	0-10	18-30	0.6-2.0	0.15-0.20	7.9-8.4	<2	Low	0.32	5	4L	B
	10-38	22-35	0.6-2.0	0.12-0.18	7.9-8.4	<2	Low	0.32			
	38-80	22-35	0.6-2.0	0.12-0.18	7.9-8.4	<2	Low	0.32			
Plack	0-8	15-32	0.6-2.0	0.10-0.18	7.9-8.4	<2	Low	0.32	1	4L	D
	8	---	---	---	---	---	---	---			
20*:											
Colmor	0-4	27-35	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.37	5	4	B
	4-32	24-35	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.49			
	32-52	17-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.43			
	52-64	25-35	0.2-0.6	0.19-0.21	7.9-8.4	<2	Moderate	0.49			
Litle	0-3	30-40	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.37	3	4L	D
	3-22	38-55	<0.06	0.14-0.19	7.9-8.4	2-8	High	0.32			
	22	---	---	---	---	---	---	---			
Kim	0-6	10-20	0.6-2.0	0.15-0.16	7.9-8.4	<2	Low	0.28	5	3	B
	6-60	18-35	0.6-2.0	0.15-0.17	7.9-8.4	<2	Moderate	0.32			
21*:											
Dallam	0-8	10-18	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low	0.24	5	3	B
	8-57	22-35	0.6-2.0	0.12-0.18	7.4-8.4	<2	Low	0.32			
	57-80	20-35	0.6-2.0	0.10-0.15	7.9-8.4	<2	Low	0.32			
Rickmore	0-8	10-20	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low	0.24	5	3	C
	8-38	30-35	0.2-0.6	0.14-0.20	7.4-8.4	<2	Moderate	0.32			
	38-80	30-35	0.2-0.6	0.10-0.16	7.9-8.4	<2	Moderate	0.32			
Vingo	0-18	5-15	6.0-20	0.06-0.10	6.6-7.8	<2	Very low	0.20	5	2	B
	18-48	14-18	2.0-6.0	0.10-0.15	6.6-7.8	<2	Low	0.24			
	48-80	14-25	0.6-2.0	0.10-0.17	7.4-8.4	<2	Low	0.32			
22*:											
Manzano	0-14	10-25	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low	0.28	5	6	C
	14-60	18-34	0.2-0.6	0.16-0.21	7.4-8.4	<2	Moderate	0.32			
Alicia	0-6	15-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low	0.49	5	4L	B
	6-20	27-35	0.2-0.6	0.16-0.18	7.9-8.4	<2	Moderate	0.49			
	20-60	18-33	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.49			
Kim	0-6	12-25	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.32	5	4L	B
	6-60	18-35	0.6-2.0	0.15-0.17	7.9-8.4	<2	Moderate	0.32			
23*:											
Aridic Argiustolls.											
Rock outcrop.											
24*:											
Colmor	0-4	20-27	0.2-0.6	0.19-0.21	7.4-7.8	<2	Low	0.37	5	4L	B
	4-32	24-35	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.49			
	32-52	17-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.43			
	52-64	25-35	0.2-0.6	0.19-0.21	7.9-8.4	<2	Moderate	0.49			
Swastika	0-4	18-25	0.2-0.6	0.19-0.21	6.6-7.3	<2	Low	0.37	5	6	C
	4-11	30-40	0.2-0.6	0.19-0.21	6.6-7.3	<2	Moderate	0.37			
	11-30	40-50	0.06-0.2	0.15-0.17	7.4-8.4	<2	High	0.32			
	30-64	30-40	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate	0.43			
Kim	0-6	12-25	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.32	5	4L	B
	6-60	18-35	0.6-2.0	0.15-0.17	7.9-8.4	<2	Moderate	0.32			

See footnote at end of table.

TABLE C-3-PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Hydro-logic group
								K	T		
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
25*:											
Mion------------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-8.4	<2	Moderate-----	0.37	2	4	D
	4-14	40-55	<0.06	0.15-0.17	7.4-8.4	<2	High---------	0.32			
	14	---	---	---	---	---	-------------	----			
Vermejo---------	0-2	30-40	0.2-0.6	0.19-0.21	7.9-9.0	>2	Moderate-----	0.32	5	4L	D
	2-60	40-55	<0.06	0.15-0.17	7.9-9.0	>2	High---------	0.32			
Litle-----------	0-3	30-40	0.2-0.6	0.19-0.21	7.4-8.4	<2	Moderate-----	0.37	3	4L	D
	3-22	38-55	<0.06	0.14-0.19	7.9-8.4	2-8	High---------	0.32			
	22	---	---	---	---	---	-------------	----			
26*:											
Raton-----------	0-9	20-27	0.2-0.6	0.10-0.12	6.6-7.3	<2	Low----------	0.28	1	8	D
	9-15	35-55	0.06-0.2	0.08-0.09	6.6-7.3	<2	High---------	0.20			
	15	---	---	---	---	---	-------------	----			
Barela----------	0-4	18-25	0.2-0.6	0.19-0.21	6.6-7.3	<2	Moderate-----	0.32	4	5	C
	4-12	35-45	0.2-0.6	0.19-0.21	6.6-7.3	<2	Moderate-----	0.37			
	12-31	40-50	0.06-0.2	0.11-0.13	6.6-7.3	<2	High---------	0.24			
	31-41	40-50	0.06-0.2	0.07-0.08	7.4-8.4	<2	High---------	0.20			
	41	---	---	---	---	---	-------------	----			
27*:											
Morval----------	0-21	27-32	0.6-2.0	0.18-0.21	6.6-8.4	<2	Moderate-----	0.37	5	6	B
	21-57	28-35	0.6-2.0	0.14-0.21	7.4-8.4	<2	Moderate-----	0.43			
	57-60	28-35	0.6-2.0	0.06-0.10	7.4-8.4	<2	Moderate-----	0.24			
	60-70	20-35	0.6-2.0	0.08-0.10	7.9-8.4	<2	Moderate-----	0.24			
Moreno----------	0-8	18-27	0.6-2.0	0.14-0.17	6.6-7.3	<2	Moderate-----	0.24	5	6	C
	8-37	35-50	0.2-0.6	0.16-0.20	6.6-7.3	<2	Moderate-----	0.28			
	37-60	35-50	0.06-0.2	0.10-0.14	6.6-7.3	<2	High---------	0.15			
Brycan----------	0-12	5-15	2.0-6.0	0.14-0.16	7.4-7.8	<2	Low----------	0.43	5	3	B
	12-37	20-30	0.6-2.0	0.14-0.19	7.4-7.8	<2	Low----------	0.20			
	37-62	20-30	0.2-0.6	0.16-0.19	7.4-8.4	<2	Moderate-----	0.37			
28*:											
Bundo-----------	0-30	10-20	2.0-6.0	0.08-0.10	5.1-6.0	<2	Low----------	0.24	5	5	B
	30-56	10-20	2.0-6.0	0.10-0.12	5.6-6.5	<2	Low----------	0.20			
	56-80	10-25	2.0-6.0	0.08-0.10	5.6-6.5	<2	Low----------	0.10			
Angostura-------	0-7	15-25	0.6-2.0	0.07-0.13	5.6-6.0	<2	Low----------	0.28	5	---	B
	7-22	20-30	0.6-2.0	0.07-0.11	5.1-6.0	<2	Low----------	0.24			
	22-60	20-30	0.6-2.0	0.01-0.08	5.1-6.0	<2	Low----------	0.24			
Tolby-----------	0-22	8-27	2.0-6.0	0.08-0.11	<4.5	<2	Low----------	0.28	5	6	B
	22-44	4-12	6.0-20	0.05-0.07	4.5-5.5	<2	Low----------	0.17			
	44-57	5-15	6.0-20	0.07-0.09	5.1-5.5	<2	Low----------	0.15			
	57-80	4-12	6.0-20	0.03-0.06	5.6-6.0	<2	Low----------	0.15			
29*:											
Burnac----------	0-12	20-27	0.6-2.0	0.12-0.15	6.1-7.3	<2	Low----------	0.28	3	8	D
	12-31	35-50	<0.06	0.14-0.16	6.1-7.3	<2	High---------	0.24			
	31-53	35-50	0.06-0.2	0.07-0.10	6.6-7.8	<2	Moderate-----	0.28			
	53	---	---	---	---	---	-------------	----			
Fuera-----------	0-15	10-25	0.6-2.0	0.10-0.14	6.1-7.3	<2	Low----------	0.28	5	8	C
	15-31	45-60	0.06-0.2	0.10-0.15	6.1-7.3	<2	High---------	0.28			
	31-58	45-60	0.06-0.2	0.08-0.12	6.1-7.3	<2	High---------	0.28			
	58-64	35-60	0.06-0.2	0.07-0.11	6.6-7.8	<2	Moderate-----	0.24			
Hillery---------	0-18	15-27	0.6-2.0	0.13-0.15	5.6-7.3	<2	Low----------	0.28	5	6	D
	18-60	50-60	0.06-0.2	0.11-0.16	5.6-7.3	<2	High---------	0.24			

See footnote at end of table.

TABLE C-3-PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydro- logic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
30*:											
Etoe------------	0-11	10-23	0.6-2.0	0.12-0.14	6.1-7.3	<2	Low-----------	0.15	5	---	B
	11-36	10-25	0.6-2.0	0.10-0.14	6.1-6.5	<2	Low-----------	0.15			
	36-73	20-25	0.6-2.0	0.05-0.11	6.1-7.3	<2	Low-----------	0.15			
Etown-----------	0-18	8-17	2.0-6.0	0.07-0.09	6.1-6.5	<2	Low-----------	0.28	5	8	B
	18-30	30-40	0.2-0.6	0.07-0.09	6.1-6.5	<2	Moderate-----	0.24			
	30-60	35-50	0.2-0.6	0.07-0.09	6.1-6.5	<2	Moderate-----	0.20			
Angostura-------	0-7	15-25	0.6-2.0	0.07-0.13	5.6-6.0	<2	Low-----------	0.28	5	---	B
	7-22	20-30	0.6-2.0	0.07-0.11	5.1-6.0	<2	Low-----------	0.24			
	22-60	20-30	0.6-2.0	0.01-0.08	5.1-6.0	<2	Low-----------	0.24			
31*:											
Dargol----------	0-6	15-27	0.6-2.0	0.13-0.15	5.6-6.5	<2	Low-----------	0.24	3	7	D
	6-35	40-55	<0.06	0.14-0.16	5.6-6.5	<2	High----------	0.28			
	35	---	---	---	---	---	--------------	----			
Fuera-----------	0-15	10-25	0.6-2.0	0.10-0.14	6.1-7.3	<2	Low-----------	0.28	5	8	C
	15-31	45-60	0.06-0.2	0.10-0.15	6.1-7.3	<2	High----------	0.28			
	31-58	45-60	0.06-0.2	0.08-0.12	6.1-7.3	<2	High----------	0.28			
	58-64	35-60	0.06-0.2	0.07-0.11	6.6-7.8	<2	Moderate-----	0.24			
Vamer-----------	0-4	15-25	0.6-2.0	0.10-0.16	6.6-7.3	<2	Low-----------	0.28	1	---	D
	4-16	40-55	0.06-0.2	0.11-0.18	6.6-7.3	<2	High----------	0.32			
	16	---	---	---	---	---	--------------	----			
32*:											
Torreon---------	0-6	14-22	0.6-2.0	0.16-0.21	6.6-7.3	<2	Low-----------	0.28	5	6	C
	6-12	35-40	0.2-0.6	0.19-0.21	6.6-7.8	<2	High----------	0.24			
	12-40	40-55	0.06-0.2	0.14-0.18	6.6-7.8	<2	High----------	0.24			
	40-60	35-40	0.2-0.6	0.16-0.21	7.4-8.4	<2	High----------	0.24			
	60	---	---	---	---	---	--------------	----			
Thunderbird-----	0-2	27-35	0.2-0.6	0.16-0.21	6.6-7.8	<2	Moderate-----	0.43	2	8	D
	2-31	35-55	<0.06	0.12-0.18	7.9-8.4	<2	High----------	0.24			
	31	---	---	---	---	---	--------------	----			
Crews-----------	0-5	10-25	0.6-2.0	0.17-0.20	6.6-7.8	<2	Low-----------	0.32	1	5	D
	5-16	35-50	0.2-0.6	0.14-0.20	6.6-7.8	<2	High----------	0.37			
	16	---	---	---	---	---	--------------	----			
33*:											
Rednun----------	0-6	15-27	0.6-2.0	0.16-0.19	6.6-7.3	<2	Low-----------	0.24	5	5	C
	6-42	35-55	0.06-0.2	0.16-0.18	7.4-8.4	<2	High----------	0.22			
	42-60	20-40	0.2-0.6	0.16-0.18	7.9-8.4	<2	Moderate-----	0.28			
Carnero---------	0-9	20-27	0.2-0.6	0.17-0.19	6.6-7.8	<2	Low-----------	0.24	2	6	C
	9-28	35-50	0.06-0.2	0.13-0.20	6.6-8.4	<2	High----------	0.24			
	28	---	---	---	---	---	--------------	----			
Tricon----------	0-7	20-27	0.2-2.0	0.19-0.21	6.6-7.8	<2	Low-----------	0.32	2	6	C
	7-33	35-50	0.06-0.2	0.14-0.21	6.6-8.4	<2	High----------	0.28			
	33-39	20-35	0.2-0.6	0.13-0.15	6.6-8.4	<2	Moderate-----	0.28			
	39	---	---	---	---	---	--------------	----			
34*:											
La Brier--------	0-13	18-27	0.6-2.0	0.16-0.19	6.6-8.4	<2	Low-----------	0.32	5	6	C
	13-49	35-60	<0.06	0.16-0.20	7.4-8.4	<2	High----------	0.32			
	49-77	30-40	0.06-0.2	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
Manzano---------	0-14	10-25	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low-----------	0.28	5	6	C
	14-60	18-34	0.2-0.6	0.16-0.21	7.4-8.4	<2	Moderate-----	0.32			
Loma------------	0-5	15-27	0.6-2.0	0.14-0.18	7.9-8.4	<2	Low-----------	0.28	5	5	C
	5-28	35-50	0.06-0.2	0.15-0.17	7.9-8.4	<2	High----------	0.28			
	28-60	27-40	0.6-2.0	0.15-0.17	7.9-8.4	<2	Moderate-----	0.32			

See footnote at end of table.

TABLE C-3--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydro- logic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
35*:											
Remunda----------	0-12	18-28	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low-----------	0.28	5	6	D
	12-38	35-50	0.06-0.2	0.16-0.19	6.6-8.4	<2	High----------	0.28			
	38-60	25-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate------	0.28			
Stroupe----------	0-7	18-27	0.6-2.0	0.05-0.07	6.6-7.8	<2	Low-----------	0.24	2	8	C
	7-24	35-50	0.06-0.2	0.07-0.09	6.6-8.4	<2	Moderate------	0.24			
	24	---	---	---	---	---	--------------	----			
Crews------------	0-5	10-25	0.6-2.0	0.11-0.14	6.6-7.8	<2	Low-----------	0.32	1	6	D
	5-16	35-50	0.2-0.6	0.14-0.20	6.6-7.8	<2	High----------	0.37			
	16	---	---	---	---	---	--------------	----			
36*:											
Bernal-----------	0-12	15-20	2.0-6.0	0.13-0.16	6.6-7.8	<2	Low-----------	0.28	1	3	D
	12	---	---	---	---	---	--------------	----			
Travessilla------	0-4	10-18	0.6-2.0	0.09-0.12	6.6-8.4	<2	Low-----------	0.32	1	5	D
	4-8	10-18	0.6-2.0	0.13-0.15	6.6-8.4	<2	Low-----------	0.32			
	8	---	---	---	---	---	--------------	----			
Crews------------	0-5	10-25	0.6-2.0	0.17-0.20	6.6-7.8	<2	Low-----------	0.32	1	5	D
	5-16	35-50	0.2-0.6	0.14-0.20	6.6-7.8	<2	High----------	0.37			
	16	---	---	---	---	---	--------------	----			
37*:											
Apache-----------	0-16	25-35	0.6-2.0	0.12-0.16	7.4-8.4	<2	Low-----------	0.28	1	8	D
	16	---	---	---	---	---	--------------	----			
Capulin----------	0-10	18-27	0.6-2.0	0.12-0.14	6.6-7.8	<2	Moderate------	0.37	5	5	B
	10-41	18-35	0.6-2.0	0.14-0.16	7.4-9.0	<2	Moderate------	0.37			
	41-66	20-30	0.6-2.0	0.11-0.13	7.4-9.0	<2	Moderate------	0.37			
Rock outcrop.											
38*:											
Bond-------------	0-4	15-27	---	---	---	---	--------------	----	---	---	D
	4-17	20-35	0.2-0.6	0.11-0.13	6.6-8.4	<2	Moderate------	0.37			
	17	---	---	---	---	---	--------------	----			
Fortwingate------	0-13	15-25	0.6-2.0	0.12-0.14	5.6-7.3	<2	Low-----------	0.32	2	6	C
	13-23	35-45	0.2-0.6	0.15-0.17	5.6-7.3	<2	High----------	0.28			
	23-32	35-45	0.06-0.2	0.16-0.19	5.6-7.3	<2	High----------	0.24			
	32	---	---	---	---	---	--------------	----			
39*:											
Rock outcrop.											
Encierro---------	0-5	27-35	0.2-0.6	0.12-0.14	7.4-7.8	<2	Moderate------	0.28	1	8	D
	5-14	35-50	0.06-0.2	0.14-0.16	6.1-8.4	<2	High----------	0.32			
	14	---	---	---	---	---	--------------	----			
Bernal-----------	0-12	20-27	0.6-2.0	0.18-0.21	6.6-7.8	<2	Moderate------	0.32	1	6	D
	12	---	---	---	---	---	--------------	----			
40*:											
Nambe------------	0-8	6-15	2.0-6.0	0.09-0.12	3.6-5.5	<2	Low-----------	0.17	5	8	B
	8-18	6-15	2.0-6.0	0.06-0.09	3.6-5.5	<2	Low-----------	0.15			
	18-60	6-15	2.0-6.0	0.05-0.08	3.6-5.5	<2	Low-----------	0.15			
Cundiyo----------	0-14	5-10	2.0-6.0	0.05-0.07	6.1-7.3	<2	Low-----------	0.20	5	4	B
	14-46	5-14	2.0-6.0	0.04-0.06	6.1-7.3	<2	Low-----------	0.28			
	46-60	0-5	6.0-20	0.02-0.04	6.1-7.3	<2	Low-----------	0.10			

See footnote at end of table.

TABLE C-3 -PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydrologic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
41*:											
Gaines----------	0-9	30-40	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate-----	0.32	3	4	C
	9-15	30-40	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate-----	0.32			
	15-32	35-60	0.06-0.2	0.12-0.14	6.6-7.8	<2	High---------	0.28			
	32-48	35-60	0.06-0.2	0.02-0.04	6.6-7.8	<2	Low----------	0.05			
	48	---	---	---	---	---	-------------	----			
Hayspur---------	0-5	18-27	0.6-2.0	0.17-0.20	6.6-9.0	8-16	Low----------	0.37	5	4L	D
	5-38	18-30	0.6-2.0	0.19-0.21	6.6-9.0	8-16	Moderate-----	0.37			
	38-42	10-17	2.0-6.0	0.13-0.15	6.6-7.8	8-16	Low----------	0.24			
	42-60	0-5	6.0-20	0.04-0.06	6.6-7.8	8-16	Low----------	0.05			
42*:											
Vermejo---------	0-2	30-40	0.2-0.6	0.19-0.21	7.9-9.0	>2	Moderate-----	0.32	5	4L	D
	2-60	40-55	<0.06	0.15-0.17	7.9-9.0	>2	High---------	0.32			
Remunda---------	0-12	18-28	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low----------	0.28	5	6	D
	12-38	35-50	0.06-0.2	0.16-0.19	6.6-8.4	<2	High---------	0.28			
	38-60	25-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate-----	0.28			
Partri----------	0-4	18-28	0.6-2.0	0.16-0.21	6.6-8.4	<2	Low----------	0.37	5	6	C
	4-29	35-55	0.06-0.2	0.14-0.21	6.6-8.4	<2	High---------	0.32			
	29-60	35-40	0.2-0.6	0.15-0.17	7.9-8.4	<2	Moderate-----	0.28			
43*:											
Pullman---------	0-6	27-40	0.2-0.6	0.14-0.19	6.6-8.4	<2	Moderate-----	0.37	5	6	D
	6-38	40-55	<0.06	0.12-0.17	7.4-8.4	<2	High---------	0.37			
	38-78	38-50	0.06-0.2	0.10-0.16	7.9-8.4	<2	Moderate-----	0.37			
Mansker---------	0-12	20-30	0.6-2.0	0.13-0.19	7.9-8.4	<2	Low----------	0.28	3	4L	B
	12-28	20-35	0.6-2.0	0.08-0.16	7.9-8.4	<2	Low----------	0.28			
	28-66	15-40	0.6-2.0	0.10-0.18	7.9-8.4	<2	Low----------	0.28			
Amarillo--------	0-11	10-18	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low----------	0.24	5	3	B
	11-38	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Low----------	0.32			
	38-80	20-35	0.6-2.0	0.10-0.15	7.9-8.4	<2	Low----------	0.32			
44*:											
Mansker---------	0-12	20-30	0.6-2.0	0.13-0.19	7.9-8.4	<2	Low----------	0.28	3	4L	B
	12-28	20-35	0.6-2.0	0.08-0.16	7.9-8.4	<2	Low----------	0.28			
	28-66	15-40	0.6-2.0	0.10-0.18	7.9-8.4	<2	Low----------	0.28			
Potter----------	0-9	18-25	0.6-2.0	0.10-0.16	7.9-8.4	<2	Low----------	0.28	1	---	C
	9-30	---	0.6-6.0	0.01-0.06	7.9-8.4	<2	Low----------	----			
45*:											
Bascom----------	0-16	10-20	2.0-6.0	0.13-0.17	7.9-8.4	<2	Low----------	0.32	2	3	B
	16-36	10-25	2.0-6.0	0.04-0.08	8.5-9.0	2-4	Low----------	0.20			
	36-72	10-20	2.0-6.0	0.12-0.16	8.5-9.0	2-4	Low----------	0.37			
Potter----------	0-9	18-25	0.6-2.0	0.10-0.16	7.9-8.4	<2	Low----------	0.28	1	---	C
	9-30	---	0.6-6.0	0.01-0.06	7.9-8.4	<2	Low----------	----			
Olton-----------	0-8	22-35	0.6-2.0	0.15-0.20	6.6-8.4	<2	Moderate-----	0.32	5	6	C
	8-48	35-45	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate-----	0.32			
	48-80	25-40	0.2-0.6	0.10-0.16	7.9-8.4	<2	Moderate-----	0.32			
46*:											
Amarillo--------	0-11	10-18	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low----------	0.24	5	3	B
	11-38	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Low----------	0.32			
	38-80	20-35	0.6-2.0	0.10-0.15	7.9-8.4	<2	Low----------	0.32			
Ima-------------	0-10	5-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.37	5	3	B
	10-40	8-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.43			
	40-60	8-18	2.0-6.0	0.11-0.17	7.9-8.4	<2	Low----------	0.43			

See footnote at end of table.

TABLE C-3 -PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Hydro-logic group
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
46*:											
Bascom----------	0-16	10-20	2.0-6.0	0.13-0.17	7.9-8.4	<2	Low----------	0.32	2	3	B
	16-36	10-25	2.0-6.0	0.04-0.08	8.5-9.0	2-4	Low----------	0.20			
	36-72	10-20	2.0-6.0	0.12-0.16	8.5-9.0	2-4	Low----------	0.37			
47*:											
Quay------------	0-9	10-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low----------	0.37	5	4L	B
	9-26	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
	26-60	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.37			
Montoya---------	0-4	30-40	0.2-0.6	0.19-0.21	7.4-8.4	2-8	High---------	0.37	5	4	D
	4-60	35-60	<0.06	0.14-0.16	7.4-8.4	2-8	High---------	0.37			
Lacita----------	0-8	15-25	0.2-0.6	0.19-0.21	7.9-8.4	<2	Low----------	0.49	5	4L	B
	8-72	20-35	0.2-0.6	0.19-0.21	7.9-8.4	<2	Moderate-----	0.49			
48*:											
Ima-------------	0-10	5-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.37	5	3	B
	10-40	8-18	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low----------	0.43			
	40-60	8-18	2.0-6.0	0.11-0.17	7.9-8.4	<2	Low----------	0.43			
Tucumcari-------	0-8	27-35	0.2-0.6	0.19-0.21	6.6-8.4	2-4	Moderate-----	0.37	5	4L	B
	8-45	35-45	0.2-0.6	0.14-0.21	7.4-8.4	2-4	High---------	0.32			
	45-60	35-40	0.2-0.6	0.19-0.21	7.9-8.4	2-4	Moderate-----	0.32			
49*:											
Redona----------	0-10	10-15	0.6-2.0	0.12-0.15	7.4-7.8	<2	Low----------	0.24	5	3	B
	10-60	20-35	0.6-2.0	0.14-0.21	7.4-8.4	<2	Moderate-----	0.32			
Canez-----------	0-8	5-15	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low----------	0.32	5	3	B
	8-48	18-25	0.6-2.0	0.12-0.16	6.6-8.4	<2	Low----------	0.32			
	48-67	18-25	0.6-2.0	0.12-0.16	7.9-8.4	<2	Low----------	0.32			
Quay------------	0-9	10-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low----------	0.37	5	4L	B
	9-26	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
	26-60	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.37			
50*:											
Lacita----------	0-8	15-25	0.2-0.6	0.19-0.21	7.9-8.4	<2	Low----------	0.49	5	4L	B
	8-72	20-35	0.2-0.6	0.19-0.21	7.9-8.4	<2	Moderate-----	0.49			
La Lande--------	0-9	10-25	0.6-2.0	0.11-0.18	7.4-8.4	<2	Low----------	0.37	5	5	B
	9-24	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.32			
	24-60	18-30	0.6-2.0	0.14-0.18	7.9-8.4	<2	Low----------	0.32			
Quay------------	0-9	10-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low----------	0.37	5	4L	B
	9-26	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate-----	0.37			
	26-60	18-35	0.6-2.0	0.14-0.21	7.9-8.4	<2	Moderate-----	0.37			
51*:											
Latom-----------	0-8	5-18	0.6-2.0	0.10-0.13	7.9-8.4	<2	Low----------	0.24	1	8	D
	8	---	---	---	---	---	-------------	----			
Rock outcrop.											
52*:											
Tucumcari-------	0-8	27-35	0.2-0.6	0.19-0.21	6.6-8.4	2-4	Moderate-----	0.37	5	4L	B
	8-45	35-45	0.2-0.6	0.14-0.21	7.4-8.4	2-4	High---------	0.32			
	45-60	35-40	0.2-0.6	0.19-0.21	7.9-8.4	2-4	Moderate-----	0.32			
Montoya---------	0-4	30-40	0.2-0.6	0.19-0.21	7.4-8.4	2-8	High---------	0.37	5	4	D
	4-60	35-60	<0.06	0.14-0.16	7.4-8.4	2-8	High---------	0.37			
Redona----------	0-10	10-15	0.6-2.0	0.12-0.15	7.4-7.8	<2	Low----------	0.24	5	3	B
	10-60	20-35	0.6-2.0	0.14-0.21	7.4-8.4	<2	Moderate-----	0.32			

See footnote at end of table.

TABLE C-3-PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Hydro-logic group
								K	T		
	In	Pct	In/hr	In/in	pH	Mmhos/cm					
53*:											
Carnero---------	0-9	20-27	0.2-0.6	0.17-0.19	6.6-7.8	<2	Low----------	0.24	2	6	C
	9-28	35-50	0.06-0.2	0.13-0.20	6.6-8.4	<2	High---------	0.24			
	28	---	---	---	---	---	-------------	----			
Rednun----------	0-6	15-27	0.6-2.0	0.16-0.19	6.6-7.3	<2	Low----------	0.24	5	5	C
	6-42	35-55	0.06-0.2	0.16-0.18	7.4-8.4	<2	High---------	0.22			
	42-60	20-40	0.2-0.6	0.16-0.18	7.9-8.4	<2	Moderate-----	0.28			
Bernal----------	0-12	20-27	0.6-2.0	0.18-0.21	6.6-7.8	<2	Moderate-----	0.32	1	6	D
	12	---	---	---	---	---	-------------	----			
54*:											
Chimayo---------	0-6	10-18	0.6-2.0	0.15-0.17	6.6-7.3	<2	Low----------	0.32	1	---	D
	6-20	10-18	0.6-2.0	0.08-0.10	6.6-7.3	<2	Low----------	0.24			
	20	---	---	---	---	---	-------------	----			
Mirabal---------	0-5	10-20	2.0-6.0	0.07-0.09	5.6-7.3	<2	Low----------	0.28	2	8	C
	5-23	10-20	2.0-6.0	0.07-0.09	5.6-7.3	<2	Low----------	0.28			
	23	---	---	---	---	---	-------------	----			
Supervisor------	0-10	7-18	2.0-6.0	0.08-0.10	5.6-7.3	<2	Low----------	0.20	2	8	C
	10-16	7-18	2.0-6.0	0.08-0.10	5.6-7.3	<2	Low----------	0.20			
	16-22	7-18	2.0-6.0	0.08-0.10	5.6-7.3	<2	Low----------	0.20			
	22	---	---	---	---	---	-------------	----			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE C-4 -WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
2*:						
Lacita----------	Slight---------	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Redona----------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Soil blowing---	Favorable.
Quay------------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
3*:						
San Jon---------	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Los Tanos--------	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, depth to rock, slope.	Depth to rock, soil blowing.	Depth to rock.
Ima-------------	Severe: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
4*:						
Conchas----------	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Latom-----------	Severe: depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Quay------------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
5*:						
Redona----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Soil blowing---	Favorable.
Bascom----------	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily, droughty.
Canez-----------	Moderate: seepage.	Severe: piping.	Deep to water	Soil blowing---	Soil blowing---	Favorable.
6*:						
Rock outcrop.						
Orthents.						
Ustolls.						
7*:						
Gruver----------	Slight---------	Moderate: hard to pack.	Deep to water	Favorable------	Favorable------	Favorable.
La Brier---------	Slight---------	Moderate: hard to pack.	Deep to water	Percs slowly---	Percs slowly---	Percs slowly.
Dumas-----------	Moderate: seepage.	Moderate: piping.	Deep to water	Rooting depth	Favorable------	Rooting depth.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
8*:						
Litle	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock	Depth to rock.
Berthoud	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Penrose	Severe: depth to rock.	Severe: piping.	Deep to water	Depth to rock, slope.	Large stones, depth to rock.	Large stones, depth to rock.
9*:						
Berthoud	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Kinkead	Moderate: seepage.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
10*:						
Church	Slight	Moderate: hard to pack, wetness, excess salt.	Deep to water	Percs slowly, floods, excess salt.	Percs slowly	Excess salt, percs slowly.
Karde	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, excess salt.	Erodes easily	Excess salt, erodes easily.
11*:						
Campus.						
Dean	Moderate: slope.	Moderate: piping.	Deep to water	Droughty, percs slowly, slope.	Percs slowly	Droughty, percs slowly.
12*:						
Mansker	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, rooting depth.	Soil blowing	Droughty, rooting depth.
Portales	Moderate: seepage.	Moderate: piping.	Deep to water	Soil blowing	Erodes easily, soil blowing.	Erodes easily.
13*:						
Otero	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, slope.	Soil blowing	Droughty.
Dalhart	Severe: seepage.	Severe: thin layer.	Deep to water	Soil blowing	Soil blowing	Favorable.
14*:						
Amarillo	Moderate: seepage.	Moderate: piping.	Deep to water	Fast intake, soil blowing.	Soil blowing	Favorable.
Springer	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, slope.	Too sandy, soil blowing.	Favorable.
Brownfield	Severe: seepage.	Slight	Deep to water	Droughty, fast intake, soil blowing.	Soil blowing	Droughty.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
15*:						
Springer	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, slope.	Too sandy, soil blowing.	Favorable.
Tivoli	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Amarillo	Moderate: seepage.	Moderate: piping.	Deep to water	Fast intake, soil blowing.	Soil blowing	Favorable.
16*:						
Apache	Severe: depth to rock.	Severe: large stones.	Deep to water	Large stones, depth to rock, slope.	Large stones, depth to rock.	Large stones, depth to rock.
Torreon	Slight	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Tricon	Moderate: cemented pan.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, cemented pan.	Cemented pan, percs slowly.	Cemented pan, percs slowly.
17*:						
Travessilla	Severe: depth to rock.	Severe: thin layer.	Deep to water	Large stones, depth to rock, slope.	Large stones, depth to rock.	Large stones, depth to rock.
Carnero	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, percs slowly.	Depth to rock, percs slowly.
Rock outcrop.						
18*:						
Gallegos	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
Gallegos	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
Gallegos	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
19*:						
Spurlock	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Texline	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Plack	Severe: cemented pan.	Severe: thin layer.	Deep to water	Cemented pan, slope.	Cemented pan	Cemented pan.
20*:						
Colmor	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
20*:						
Litle	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock	Depth to rock.
Kim	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
21*:						
Dallam	Moderate: seepage.	Moderate: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
Rickmore	Slight	Moderate: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
Vingo	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Soil blowing	Droughty.
22*:						
Manzano	Slight	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
Alicia	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Kim	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
23*:						
Aridic Argiustolls.						
Rock outcrop.						
24*:						
Colmor	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Swastika	Slight	Moderate: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Kim	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
25*:						
Mion	Severe: depth to rock.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Vermejo	Slight	Severe: excess salt.	Deep to water	Percs slowly, excess salt.	Percs slowly	Excess salt, percs slowly.
Litle	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock	Depth to rock.
26*:						
Raton	Severe: depth to rock.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Large stones, depth to rock.	Large stones, droughty.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
26*:						
Barela	Moderate: depth to rock.	Moderate: hard to pack, large stones.	Deep to water	Large stones, percs slowly.	Large stones, erodes easily.	Large stones, erodes easily.
27*:						
Morval	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Moreno	Severe: slope.	Slight	Deep to water	Percs slowly, slope.	Slope, large stones.	Slope, percs slowly.
Brycan	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
28*:						
Bundo	Severe: seepage, slope.	Moderate: seepage, large stones.	Deep to water	Droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
Angostura	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
Tolby	Severe: seepage, slope.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones, too sandy.	Large stones, slope, droughty.
29*:						
Burnac	Moderate: depth to rock, slope.	Moderate: thin layer.	Deep to water	Percs slowly, slope.	Large stones, percs slowly.	Percs slowly.
Fuera	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Slope, large stones, percs slowly.	Large stones, slope, droughty.
Hillery	Moderate: depth to rock, slope.	Moderate: piping, hard to pack, large stones.	Deep to water	Large stones, percs slowly, slope.	Large stones, percs slowly.	Large stones, percs slowly.
30*:						
Etoe	Severe: slope.	Severe: piping, large stones.	Deep to water	Large stones, slope.	Slope, large stones.	Large stones, slope.
Etown	Severe: slope.	Moderate: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope.
Angostura	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
31*:						
Dargol	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Fuera	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Slope, large stones, percs slowly.	Large stones, slope, droughty.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
31*:						
Vamer	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
32*:						
Torreon	Slight	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Thunderbird	Moderate: depth to rock.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Depth to rock	Depth to rock.
Crews	Severe: cemented pan.	Severe: thin layer.	Deep to water	Cemented pan, slope.	Cemented pan, erodes easily.	Erodes easily, cemented pan.
33*:						
Rednun	Slight	Moderate: hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Carnero	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, percs slowly.	Depth to rock, percs slowly.
Tricon	Moderate: cemented pan, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, cemented pan, slope.	Cemented pan, percs slowly.	Cemented pan, percs slowly.
34*:						
La Brier	Slight	Moderate: hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Manzano	Slight	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
Loma	Moderate: seepage, slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Favorable	Percs slowly.
35*:						
Remunda	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope.	Percs slowly	Percs slowly.
Stroupe	Moderate: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Large stones, depth to rock.	Large stones, droughty.
Crews	Severe: cemented pan.	Severe: thin layer.	Deep to water	Cemented pan, slope.	Cemented pan, erodes easily.	Erodes easily, cemented pan.
36*:						
Bernal	Severe: depth to rock.	Severe: piping.	Deep to water	Soil blowing, depth to rock, slope.	Depth to rock, soil blowing.	Depth to rock.
Travessilla	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Large stones, depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Crews	Severe: cemented pan.	Severe: thin layer.	Deep to water	Cemented pan, slope.	Cemented pan, erodes easily.	Erodes easily, cemented pan.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
37*:						
Apache	Severe: depth to rock.	Severe: large stones.	Deep to water	Large stones, depth to rock, slope.	Large stones, depth to rock.	Large stones, depth to rock.
Capulin	Moderate: seepage.	Moderate: thin layer, large stones.	Deep to water	Large stones, erodes easily.	Large stones, erodes easily.	Large stones, erodes easily.
Rock outcrop.						
38*:						
Bond	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, erodes easily.
Fortwingate	Severe: slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
39*:						
Rock outcrop.						
Encierro	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Bernal	Severe: depth to rock.	Moderate: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
40*:						
Nambe	Severe: seepage.	Severe: seepage.	Deep to water	Large stones, droughty.	Large stones	Large stones, droughty.
Cundiyo	Severe: seepage, slope.	Moderate: thin layer, seepage, large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
41*:						
Gaines	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, large stones.	Deep to water	Large stones, percs slowly, slope.	Large stones, percs slowly.	Large stones, percs slowly.
Hayspur	Severe: seepage.	Severe: piping, wetness.	Floods, frost action, excess salt.	Wetness, erodes easily, floods.	Erodes easily, wetness.	Wetness, excess salt, erodes easily.
42*:						
Vermejo	Slight	Severe: excess salt.	Deep to water	Percs slowly, excess salt.	Percs slowly	Excess salt, percs slowly.
Remunda	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Partri	Moderate: slope.	Moderate: piping.	Deep to water	Percs slowly, slope, erodes easily.	Large stones, erodes easily.	Erodes easily, percs slowly.
43*:						
Pullman	Slight	Moderate: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Mansker	Moderate: seepage.	Moderate: piping.	Deep to water	Rooting depth	Favorable	Rooting depth.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
43*:						
Amarillo	Moderate: seepage.	Moderate: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
44*:						
Mansker	Moderate: seepage.	Moderate: piping.	Deep to water	Rooting depth	Favorable	Rooting depth.
Potter	Severe: seepage.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Large stones	Large stones, droughty.
45*:						
Bascom	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily, droughty.
Potter	Severe: seepage.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Large stones	Large stones, droughty.
Olton	Slight	Slight	Deep to water	Favorable	Favorable	Favorable.
46*:						
Amarillo	Moderate: seepage.	Moderate: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
Ima	Severe: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Bascom	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily, droughty.
47*:						
Quay	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Montoya	Slight	Moderate: hard to pack.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Excess salt, erodes easily, percs slowly.
Lacita	Slight	Severe: piping.	Deep to water	Erodes easily, floods.	Erodes easily	Erodes easily.
48*:						
Ima	Severe: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Tucumcari	Slight	Moderate: hard to pack.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
49*:						
Redona	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Soil blowing	Favorable.
Canez	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
Quay	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
50*:						
Lacita	Slight	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE C-4-WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
50*:						
La Lande	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Quay	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
51*:						
Latom	Severe: depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Rock outcrop.						
52*:						
Tucumcari	Slight	Moderate: hard to pack.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Montoya	Slight	Moderate: hard to pack.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Excess salt, erodes easily, percs slowly.
Redona	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Soil blowing	Favorable.
53*:						
Carnero	Moderate: depth to rock.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock, percs slowly.	Depth to rock, percs slowly.
Rednun	Slight	Moderate: hard to pack.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Bernal	Severe: depth to rock.	Moderate: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
54*:						
Chimayo	Severe: depth to rock.	Severe: piping, large stones.	Deep to water	Large stones, depth to rock.	Large stones, depth to rock.	Large stones, depth to rock.
Mirabal	Severe: seepage.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, depth to rock.	Large stones, depth to rock.	Large stones, droughty, depth to rock.
Supervisor	Severe: seepage, slope.	Severe: seepage.	Deep to water	Large stones, droughty, depth to rock.	Slope, large stones, depth to rock.	Large stones, slope, droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE C-5 -RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2*:				
Lacita	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Severe: erodes easily.
Redona	Slight	Slight	Slight	Slight.
Quay	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
3*:				
San Jon	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, dusty.	Severe: erodes easily.
Los Tanos	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Ima	Slight	Slight	Moderate: slope.	Slight.
4*:				
Conchas	Moderate: dusty.	Moderate: dusty.	Moderate: slope, depth to rock, dusty.	Severe: erodes easily.
Latom	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Quay	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
5*:				
Redona	Slight	Slight	Moderate: slope.	Slight.
Bascom	Moderate: dusty.	Moderate: dusty.	Severe: slope.	Moderate: dusty.
Canez	Slight	Slight	Moderate: slope.	Slight.
6*:				
Rock outcrop.				
Orthents.				
Ustolls.				
7*:				
Gruver	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
La Brier	Severe: floods.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Dumas	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
8*:				
Litle	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Severe: erodes easily.
Berthoud	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Penrose	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Moderate: dusty.
9*:				
Berthoud	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Kinkead	Slight	Slight	Slight	Slight.
10*:				
Church	Severe: floods, excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
Karde	Moderate: dusty, excess salt.	Moderate: excess salt, dusty.	Moderate: slope, dusty, excess salt.	Severe: erodes easily.
11*:				
Campus	Moderate: dusty.	Moderate: dusty.	Moderate: cemented pan, dusty.	Moderate: dusty.
Dean	Moderate: small stones, dusty.	Moderate: small stones, dusty.	Severe: small stones.	Moderate: dusty.
12*:				
Mansker	Slight	Slight	Moderate: slope.	Slight.
Portales	Slight	Slight	Moderate: slope.	Severe: erodes easily.
13*:				
Otero	Slight	Slight	Moderate: slope.	Slight.
Dalhart	Slight	Slight	Moderate: slope.	Slight.
14*:				
Amarillo	Slight	Slight	Slight	Slight.
Springer	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Brownfield	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
15*:				
Springer	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
15*:				
Tivoli	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Amarillo	Slight	Slight	Slight	Slight.
16*:				
Apache	Severe: depth to rock.	Severe: depth to rock.	Severe: large stones, depth to rock.	Moderate: large stones.
Torreon	Moderate: dusty.	Moderate: dusty.	Moderate: small stones, dusty.	Moderate: dusty.
Tricon	Slight	Slight	Moderate: slope, cemented pan.	Slight.
17*:				
Travessilla	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Carnero	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, depth to rock.	Moderate: dusty.
Rock outcrop.				
18*:				
Gallegos	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Slight.
Gallegos	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Moderate: slope.
Gallegos	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope.
19*:				
Spurlock	Slight	Slight	Moderate: slope.	Slight.
Texline	Slight	Slight	Moderate: slope.	Slight.
Plack	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Slight.
20*:				
Colmor	Slight	Slight	Moderate: slope.	Severe: erodes easily.
Litle	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Severe: erodes easily.
Kim	Slight	Slight	Moderate: slope, small stones.	Slight.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
21*:				
Dallam	Slight	Slight	Moderate: slope.	Slight.
Rickmore	Slight	Slight	Slight	Slight.
Vingo	Slight	Slight	Moderate: slope.	Slight.
22*:				
Manzano	Slight	Slight	Slight	Slight.
Alicia	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Kim	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, dusty.	Moderate: dusty.
23*:				
Aridic Argiustolls.				
Rock outcrop.				
24*:				
Colmor	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Swastika	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Kim	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, dusty.	Moderate: dusty.
25*:				
Mion	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: erodes easily.
Vermejo	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
Litle	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Severe: erodes easily.
26*:				
Raton	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: large stones.
Barela	Slight	Slight	Moderate: slope.	Slight.
27*:				
Morval	Slight	Slight	Moderate: slope, small stones.	Severe: erodes easily.
Moreno	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
27*:				
Brycan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
28*:				
Bundo	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
Angostura	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Tolby	Severe: slope, too acid.	Severe: slope, too acid.	Severe: slope.	Severe: slope.
29*:				
Burnac	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: large stones, slope, small stones.	Moderate: large stones.
Fuera	Severe: slope.	Severe: slope.	Severe: large stones, slope.	Severe: slope.
Hillery	Slight	Slight	Moderate: large stones, slope, small stones.	Slight.
30*:				
Etoe	Severe: slope.	Severe: slope.	Severe: large stones, slope, small stones.	Severe: slope.
Etown	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope.
Angostura	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
31*:				
Dargol	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.
Fuera	Severe: slope.	Severe: slope.	Severe: large stones, slope.	Severe: slope.
Vamer	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
32*:				
Torreon	Moderate: dusty.	Moderate: dusty.	Moderate: small stones, dusty.	Moderate: dusty.
Thunderbird	Moderate: percs slowly.	Moderate: percs slowly.	Severe: small stones.	Slight.
Crews	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Slight.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
33*:				
Rednun	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
Carnero	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, depth to rock.	Moderate: dusty.
Tricon	Slight	Slight	Moderate: slope, cemented pan.	Slight.
34*:				
La Brier	Severe: floods.	Moderate: percs slowly, dusty.	Moderate: percs slowly, dusty.	Moderate: dusty.
Manzano	Slight	Slight	Slight	Slight.
Loma	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, dusty.	Moderate: dusty.
35*:				
Remunda	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Moderate: dusty.
Stroupe	Moderate: dusty.	Moderate: dusty.	Severe: slope.	Severe: large stones.
Crews	Severe: cemented pan.	Severe: cemented pan.	Severe: large stones, slope, cemented pan.	Moderate: large stones.
36*:				
Bernal	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Travessilla	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope, small stones.	Moderate: slope.
Crews	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Slight.
37*:				
Apache	Severe: depth to rock.	Severe: depth to rock.	Severe: large stones, slope, depth to rock.	Moderate: large stones.
Capulin	Moderate: dusty.	Moderate: dusty.	Moderate: large stones.	Severe: erodes easily.
Rock outcrop.				
38*:				
Bond	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Moderate: dusty.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
38*:				
Fortwingate----------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: large stones, slope.
39*:				
Rock outcrop.				
Encierro-------------	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope.
Bernal---------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
40*:				
Nambe----------------	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight.
Cundiyo--------------	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
41*:				
Gaines---------------	Slight---------------	Slight---------------	Severe: slope.	Slight.
Hayspur--------------	Severe: floods, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, erodes easily.
42*:				
Vermejo--------------	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
Remunda--------------	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
Partri---------------	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
43*:				
Pullman--------------	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Mansker--------------	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Amarillo-------------	Slight---------------	Slight---------------	Slight---------------	Slight.
44*:				
Mansker--------------	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Potter---------------	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Moderate: dusty.
45*:				
Bascom---------------	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, dusty.	Moderate: dusty.

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
45*:				
Potter	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Moderate: dusty.
Olton	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
46*:				
Amarillo	Slight	Slight	Slight	Slight.
Ima	Slight	Slight	Moderate: slope.	Slight.
Bascom	Slight	Slight	Moderate: slope, small stones.	Slight.
47*:				
Quay	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Montoya	Moderate: percs slowly, excess salt.	Moderate: excess salt, percs slowly.	Moderate: percs slowly.	Severe: erodes easily.
Lacita	Severe: floods.	Moderate: dusty.	Moderate: dusty.	Severe: erodes easily.
48*:				
Ima	Slight	Slight	Moderate: slope.	Slight.
Tucumcari	Slight	Slight	Slight	Severe: erodes easily.
49*:				
Redona	Slight	Slight	Slight	Slight.
Canez	Slight	Slight	Moderate: slope.	Slight.
Quay	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
50*:				
Lacita	Severe: floods.	Moderate: dusty.	Moderate: dusty.	Severe: erodes easily.
La Lande	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
Quay	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Severe: erodes easily.
51*:				
Latom	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Rock outcrop.				

See footnote at end of table.

TABLE C-5-RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
52*:				
Tucumcari	Slight	Slight	Slight	Severe: erodes easily.
Montoya	Moderate: percs slowly.	Moderate: excess salt, percs slowly.	Moderate: percs slowly.	Severe: erodes easily.
Redona	Slight	Slight	Slight	Slight.
53*:				
Carnero	Moderate: dusty.	Moderate: dusty.	Moderate: slope, small stones, depth to rock.	Moderate: dusty.
Rednun	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
Bernal	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
54*:				
Chimayo	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: large stones.
Mirabal	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Severe: large stones.
Supervisor	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE C-6 -WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
2*:												
Lacita	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Redona	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Quay	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
3*:												
San Jon	Poor	Fair	Poor	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Los Tanos	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Ima	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
4*:												
Conchas	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.
Latom	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Quay	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
5*:												
Redona	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Bascom	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Canez	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
6*:												
Rock outcrop.												
Orthents.												
Ustolls.												
7*:												
Gruver	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
La Brier	Fair	Good	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Dumas	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
8*:												
Litle	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.

See footnote at end of table.

TABLE C-6 -WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
8*:												
Berthoud	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Penrose	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
9*:												
Berthoud	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Kinkead	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Poor	---	Very poor.	Poor.
10*:												
Church	Poor	Fair	Fair	---	---	Poor	Fair	Fair	Fair	---	Fair	Poor.
Karde	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
11*:												
Campus	Fair	Good	Good	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Dean	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
12*:												
Mansker	Fair	Fair	Fair	---	---	Fair	Poor	Very poor	Fair	---	Very poor	Fair
Portales	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
13*:												
Otero	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Dalhart	Fair	Good	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
14*:												
Amarillo	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Springer	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Brownfield	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
15*:												
Springer	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Tivoli	Poor	Poor	Fair	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.
Amarillo	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
16*:												
Apache	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Torreon	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Poor	---	Very poor.	Fair.

See footnote at end of table.

TABLE C-6 -WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
16*: Tricon	Poor	Poor	Fair	---	---	Poor	Poor	Very poor.	Poor	---	Very poor.	Fair.
17*: Travessilla	Very poor.	Very poor.	Poor	---	---	Fair	Very poor.	Very poor.	Very poor.	---	Very poor.	Fair.
Carnero	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Rock outcrop.												
18*: Gallegos	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Gallegos	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Gallegos	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
19*: Spurlock	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Texline	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Plack	Very poor.	Very poor.	Poor	---	---	Very poor.	Very poor.	Very poor.	Very poor.	---	Very poor.	Very poor.
20*: Colmor	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Litle	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.
Kim	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
21*: Dallam	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Rickmore	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Vingo	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
22*: Manzano	Poor	Fair	Fair	---	---	Poor	Poor	Poor	Fair	---	Poor	Poor.
Alicia	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.
Kim	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
23*: Aridic Argiustolls.												

See footnote at end of table.

TABLE C-6-WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
23*: Rock outcrop.												
24*: Colmor	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Swastika	Poor	Fair	Fair	---	---	Fair	Poor	Poor	Fair	---	Poor	Fair
Kim	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
25*: Mion	Very poor.	Very poor.	Fair	---	---	Fair	Poor	Poor	Poor	---	Poor	Fair.
Vermejo	Poor	Poor	Fair	---	---	Poor	Poor	Poor	Poor	---	Poor	Poor.
Litle	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.
26*: Raton	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Barela	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
27*: Morval	Fair	Good	Good	---	---	Fair	Poor	Poor	Good	---	Poor	Fair.
Moreno	Poor	Fair	Good	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Brycan	Poor	Fair	Good	---	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
28*: Bundo	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Angostura	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Tolby	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
29*: Burnac	Very poor.	Very poor.	Good	---	Good	Good	Poor	Poor	Poor	Fair	Poor	---
Fuera	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Hillery	Poor	Fair	Good	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
30*: Etoe	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Etown	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Angostura	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---

See footnote at end of table.

TABLE C-6-WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
31*:												
Dargol	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Fuera	Very poor.	Very poor.	Good	---	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Vamer	Poor	Poor	Fair	---	Fair	Fair	Very poor.	Poor	Poor	Fair	Very poor.	Fair.
32*:												
Torreon	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Poor	---	Very poor.	Fair.
Thunderbird	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Crews	Poor	Poor	Fair	---	---	Fair	Poor	Very poor.	Poor	---	Very poor.	Fair.
33*:												
Rednun	Fair	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Carnero	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Tricon	Poor	Poor	Fair	---	---	Poor	Poor	Very poor.	Poor	---	Very poor.	Fair.
34*:												
La Brier	Fair	Good	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Manzano	Poor	Fair	Fair	---	---	Poor	Poor	Poor	Fair	---	Poor	Poor.
Loma	Poor	Poor	Fair	---	---	Fair	Poor	Very poor.	Poor	---	Very poor.	Fair.
35*:												
Remunda	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Poor	Poor.
Stroupe	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Crews	Poor	Poor	Fair	---	---	Fair	Poor	Very poor.	Poor	---	Very poor.	Fair.
36*:												
Bernal	Poor	Poor	Fair	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Travessilla	Very poor.	Very poor.	Poor	---	---	Fair	Very poor.	Very poor.	Very poor.	---	Very poor.	Fair.
Crews	Poor	Poor	Fair	---	---	Fair	Poor	Very poor.	Poor	---	Very poor.	Fair.
37*:												
Apache	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Capulin	Fair	Good	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Fair.

See footnote at end of table.

TABLE C-6-WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
37*: Rock outcrop.												
38*: Bond	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.
Fortwingate	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Good.
39*: Rock outcrop.												
Encierro	Very poor.	Very poor.	Poor	---	Fair	Poor	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Bernal	Poor	Poor	Fair	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
40*: Nambe	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Cundiyo	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	---
41*: Gaines	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hayspur	Very poor.	Poor	Poor	---	---	Poor	Good	Fair	Poor	---	Fair	Poor.
42*: Vermejo	Poor	Poor	Fair	---	---	Poor	Poor	Poor	Poor	---	Poor	Poor.
Remunda	Good	Good	Fair	---	---	Poor	Fair	Fair	Good	---	Fair	Poor.
Partri	Poor	Fair	Poor	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.
43*: Pullman	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Mansker	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Amarillo	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
44*: Mansker	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Potter	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
45*: Bascom	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Potter	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.

See footnote at end of table.

TABLE C-6-WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
45*:												
Olton	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
46*:												
Amarillo	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Ima	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Bascom	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
47*:												
Quay	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Montoya	Poor	Poor	Poor	---	---	Poor	Good	Good	Poor	---	Good	Poor.
Lacita	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
48*:												
Ima	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Tucumcari	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
49*:												
Redona	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Canez	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Quay	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
50*:												
Lacita	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
La Lande	Poor	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Quay	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
51*:												
Latom	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Rock outcrop.												
52*:												
Tucumcari	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Montoya	Poor	Poor	Poor	---	---	Poor	Good	Good	Poor	---	Good	Poor.
Redona	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.

See footnote at end of table.

TABLE C-6-WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
53*:												
Carnero-----------	Poor	Fair	Fair	---	---	Poor	Poor	Very poor.	Fair	---	Very poor.	Poor.
Rednun------------	Fair	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Bernal------------	Poor	Poor	Fair	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
54*:												
Chimayo-----------	Very poor.	Very poor.	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Mirabal-----------	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Supervisor--------	Very poor.	Very poor.	Good	---	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE C-7-ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
2*:										
Lacita----------	0-8	Silt loam--------	ML	A-4	>60	---	---	---	High-----	Low.
	8-72	Silt loam, silty clay loam, clay loam.	CL-ML, CL	A-4, A-6						
Redona----------	0-10	Fine sandy loam	SM	A-2, A-4	>60	---	---	---	Moderate	Low.
	10-60	Sandy clay loam, clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
Quay------------	0-9	Loam-------------	ML, CL-ML, CL	A-4	>60	---	---	---	High-----	Low.
	9-26	Clay loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6						
	26-60	Sandy clay loam, clay loam, loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
3*:										
San Jon---------	0-8	Loam-------------	ML, CL-ML	A-4	20-40	Soft	---	---	High-----	Low.
	8-12	Gravelly clay loam.	GC	A-6						
	12-26	Loam, clay loam, silty clay loam.	CL	A-6						
	26	Weathered bedrock	---	---						
Los Tanos-------	0-6	Sandy loam-------	SM	A-4, A-2	20-40	Hard	---	---	Moderate	Low.
	6-24	Sandy loam, loam	ML, SM	A-4, A-2						
	24	Unweathered bedrock.	---	---						
Ima-------------	0-10	Sandy loam-------	SM	A-2, A-4	>60	---	---	---	High-----	Low.
	10-40	Fine sandy loam, sandy loam.	SM	A-2, A-4						
	40-60	Fine sandy loam, sandy loam, very fine sandy loam.	SM, ML	A-2, A-4						
4*:										
Conchas---------	0-5	Loam-------------	CL-ML, CL	A-4, A-6	20-40	Hard	---	---	High-----	Low.
	5-30	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7						
	30	Unweathered bedrock.	---	---						
Latom-----------	0-8	Stony sandy loam	SM, SM-SC	A-2, A-4	4-20	Soft	---	---	Low------	Low.
	8-20	Unweathered bedrock.	---	---						
Quay------------	0-9	Loam-------------	ML, CL-ML, CL	A-4	>60	---	---	---	High-----	Low.
	9-26	Clay loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6						
	26-60	Sandy clay loam, clay loam, loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
5*:										
Redona----------	0-10	Fine sandy loam	SM	A-2, A-4	>60	---	---	---	Moderate	Low.
	10-60	Sandy clay loam, clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						

See footnote at end of table.

TABLE C-7.-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
5*:										
Bascom----------	0-16	Loam-------------	SM, ML	A-4	>60	---	---	---	High-----	Low.
	16-36	Very gravelly fine sandy loam, very gravelly sandy clay loam, very gravelly loam.	GM	A-1, A-2						
	36-72	Fine sandy loam, loam.	SM, ML	A-4						
Canez-----------	0-8	Fine sandy loam	SM, ML	A-4	>60	---	---	---	High-----	Low.
	8-48	Sandy loam, fine sandy loam, sandy clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6						
	48-67	Sandy loam, fine sandy loam, sandy clay loam.	ML, SM	A-4						
6*:										
Rock outcrop.										
Orthents.										
Ustolls.										
7*:										
Gruver----------	0-8	Loam-------------	CL	A-4, A-6	>60	---	---	---	Moderate	Low.
	8-52	Clay loam--------	CL, CH	A-6, A-7						
	52-80	Clay loam--------	CL	A-6, A-7						
La Brier--------	0-13	Silty clay loam	ML, CL	A-6, A-7	>60	---	---	---	High-----	Low.
	13-49	Silty clay loam, clay loam, clay.	CL, CH	A-7						
	49-77	Silty clay loam	ML, CL	A-7						
Dumas-----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	>60	---	---	---	Moderate	Low.
	7-34	Clay loam, sandy clay loam.	CL	A-6, A-7						
	34-80	Clay loam, sandy clay loam, loam.	CL	A-4, A-6						
8*:										
Litle-----------	0-3	Clay loam--------	CL	A-6, A-7	20-40	Soft	---	---	High-----	Moderate.
	3-22	Clay, silty clay, silty clay loam.	CL, CH	A-7						
	22	Weathered bedrock	---	---						
Berthoud--------	0-8	Loam-------------	CL	A-4, A-6	>60	---	---	---	Low------	Low.
	8-56	Loam, clay loam, sandy clay loam.	CL, SC	A-4, A-6						
Penrose---------	0-12	Channery loam----	ML, CL-ML, GM	A-4	10-20	Soft	---	---	High-----	Low.
	12	Unweathered bedrock.	---	---						
9*:										
Berthoud--------	0-8	Loam-------------	CL	A-4, A-6	>60	---	---	---	Low------	Low.
	8-56	Loam, clay loam, sandy clay loam.	CL, SC	A-4, A-6						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
9*:										
Kinkead	0-7	Clay loam	CL	A-6	>60	---	---	---	High	Low.
	7-42	Clay, silty clay, silty clay loam.	CL, CH	A-7						
	42-55	Sandy clay loam, clay loam.	CL-ML, CL	A-4, A-6						
10*:										
Church	0-7	Clay loam	CL	A-6, A-7	>60	---	---	---	High	Low.
	7-60	Clay, clay loam, silty clay.	CL, CH	A-6, A-7						
Karde	0-11	Loam	ML, CL-ML	A-4	>60	---	---	---	High	Low.
	11-60	Loam, clay loam, silt loam.	CL, CL-ML	A-4, A-6						
11*:										
Campus	0-8	Loam	ML, CL	A-6, A-7, A-4	>60	---	20-40	---	Low	Low.
	8-16	Loam, clay loam	CL, ML	A-6, A-7, A-4						
	16-30	Loam, clay loam	CL, ML, SC, SM	A-6, A-7, A-4						
	30	Cemented	---	---						
Dean	0-7	Gravelly loam	ML, CL-ML, SM, SM-SC	A-4	>60	---	---	---	High	Low.
	7-60	Gravelly loam	GM, SM	A-4						
12*:										
Mansker	0-12	Fine sandy loam	ML, CL-ML, SM, SM-SC	A-4	>60	---	---	---	Moderate	Low.
	12-28	Loam, sandy clay loam, clay loam.	CL, SC	A-4, A-6						
	28-66	Clay loam, sandy clay loam.	CL, SC	A-4, A-6						
Portales	0-8	Fine sandy loam	SM, SM-SC, CL-ML, ML	A-4	>60	---	---	---	High	Low.
	8-80	Loam, clay loam	CL	A-6						
13*:										
Otero	0-14	Loamy fine sand	SM	A-2	>60	---	---	---	High	Low.
	14-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM	A-2, A-1						
Dalhart	0-9	Fine sandy loam	SM, SC, ML, CL	A-4	>60	---	---	---	Moderate	Low.
	9-38	Fine sandy loam, sandy clay loam, clay loam.	SC, CL, ML	A-4, A-6						
	38-72	Fine sandy loam, sandy clay loam.	SM, SC, ML, CL	A-4, A-6						
14*:										
Amarillo	0-11	Loamy fine sand	SM, SM-SC	A-2	>60	---	---	---	Moderate	Low.
	11-38	Sandy clay loam, clay loam.	SC, SM-SC, CL	A-4, A-6						
	38-80	Sandy clay loam, clay loam.	SC, CL, SM-SC	A-4, A-6						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Bedrock: Depth	Bedrock: Hardness	Cemented pan: Depth	Cemented pan: Hardness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
	In				In		In			
14*:										
Springer--------	0-16	Loamy fine sand	SM, SP-SM, SM-SC	A-2, A-3	>60	---	---	---	Low------	Low.
	16-42	Fine sandy loam	SM, SM-SC, SP-SM	A-2						
	42-56	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3						
	56-80	Fine sandy loam, sandy clay loam.	SM, SM-SC, SC, SP-SM	A-2, A-4						
Brownfield------	0-26	Fine sand--------	SM, SP-SM, SM-SC	A-2	>60	---	---	---	Moderate	Low.
	26-80	Sandy clay loam	SC, SM-SC	A-2, A-6, A-4						
15*:										
Springer--------	0-16	Loamy fine sand	SM, SP-SM, SM-SC	A-2, A-3	>60	---	---	---	Low------	Low.
	16-42	Fine sandy loam	SM, SM-SC, SP-SM	A-2						
	42-56	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3						
	56-80	Fine sandy loam, sandy clay loam.	SM, SM-SC, SC, SP-SM	A-2, A-4						
Tivoli----------	0-7	Fine sand--------	SM, SP-SM	A-2, A-3	>60	---	---	---	Low------	Low.
	7-60	Fine sand, sand	SM, SP-SM	A-2, A-3						
Amarillo--------	0-11	Loamy fine sand	SM, SM-SC	A-2	>60	---	---	---	Moderate	Low.
	11-38	Sandy clay loam, clay loam.	SC, SM-SC, CL	A-4, A-6						
	38-80	Sandy clay loam, clay loam.	SC, CL, SM-SC	A-4, A-6						
16*:										
Apache----------	0-16	Cobbly loam------	CL	A-6	4-20	Hard	---	---	High-----	Low.
	16	Unweathered bedrock.	---	---						
Torreon---------	0-6	Silt loam--------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	6-12	Clay loam, silty clay loam.	CL	A-7						
	12-40	Silty clay, clay	CH	A-7						
	40-60	Silty clay loam, clay loam.	CL	A-7						
	60	Weathered bedrock	---	---						
Tricon----------	0-7	Silt loam--------	CL-ML, CL	A-4, A-6	>60	---	20-40	Thick	High-----	Low.
	7-33	Clay loam, clay, silty clay loam.	CL, CH	A-6, A-7						
	33-39	Gravelly clay loam.	CL, GC	A-6						
	39	Indurated--------	---	---						
17*:										
Travessilla-----	0-4	Stony loam-------	SM, GM	A-4	6-20	Hard	---	---	Moderate	Low.
	4-8	Loam, channery loam, stony loam.	GM, SM, ML	A-4						
	8	Unweathered bedrock.	---	---						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hard-ness	Uncoated steel	Concrete
	In				In		In			
17*:										
Carnero	0-9	Loam	CL-ML, ML	A-4	20-40	Hard	---	---	High	Low.
	9-28	Clay, silty clay, clay loam.	CL, CH	A-6, A-7						
	28	Unweathered bedrock.	---	---						
Rock outcrop.										
18*:										
Gallegos	0-3	Very gravelly fine sandy loam.	GM	A-1	>60	---	---	---	High	Low.
	3-21	Gravelly clay loam, very gravelly sandy clay loam, very gravelly loam.	SM-SC, SC, GM-GC, GC	A-2, A-6, A-4, A-1						
	21-60	Very gravelly sandy loam, gravelly sandy loam, gravelly coarse sand.	GP-GM, GP	A-1						
Gallegos	0-3	Very gravelly fine sandy loam.	GM	A-1	>60	---	---	---	High	Low.
	3-21	Gravelly clay loam, very gravelly sandy clay loam, very gravelly loam.	SM-SC, SC, GM-GC, GC	A-2, A-6, A-4, A-1						
	21-60	Very gravelly sandy loam, gravelly sandy loam, gravelly coarse sand.	GP-GM, GP	A-1						
Gallegos	0-3	Very gravelly fine sandy loam.	GM	A-1	>60	---	---	---	High	Low.
	3-21	Gravelly clay loam, very gravelly sandy clay loam, very gravelly loam.	SM-SC, SC, GM-GC, GC	A-2, A-6, A-4, A-1						
	21-60	Very gravelly sandy loam, gravelly sandy loam, gravelly coarse sand.	GP-GM, GP	A-1						
19*:										
Spurlock	0-7	Loam	CL, CL-ML, SC, SM-SC	A-4, A-6	>60	---	---	---	Moderate	Low.
	7-60	Clay loam, sandy clay loam.	CL	A-4, A-6						
	60-80	Clay loam, sandy clay loam.	CL	A-4, A-6						
Texline	0-10	Loam	CL	A-4, A-6	>60	---	---	---	Moderate	Low.
	10-38	Loam, clay loam	CL	A-6, A-7						
	38-80	Loam, sandy clay loam, clay loam.	CL	A-6						
Plack	0-8	Loam	CL, CL-ML	A-4, A-6	>60	---	4-20	Thin	Moderate	Low.
	8	Indurated	---	---						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
20*:										
Colmor----------	0-4	Silty clay loam	CL	A-6	>60	---	---	---	High-----	Low.
	4-32	Silty clay loam, clay loam, silt loam.	CL	A-6						
	32-52	Loam, silt loam	CL-ML, ML	A-4, A-6						
	52-64	Silty clay loam, silt loam.	CL	A-6						
Litle-----------	0-3	Clay loam--------	CL	A-6, A-7	20-40	Soft	---	---	High-----	Moderate.
	3-22	Clay, silty clay, silty clay loam.	CL, CH	A-7						
	22	Weathered bedrock	---	---						
Kim-------------	0-6	Fine sandy loam	SM, ML	A-4, A-2	>60	---	---	---	High-----	Low.
	6-60	Loam, clay loam	CL, CL-ML	A-4, A-6						
21*:										
Dallam----------	0-8	Fine sandy loam	SM, SM-SC	A-2, A-4	>60	---	---	---	Moderate	Low.
	8-57	Sandy clay loam, clay loam.	CL, SC, SM-SC	A-4, A-6						
	57-80	Clay loam, sandy clay loam.	CL, SC, SM-SC	A-6						
Rickmore--------	0-8	Fine sandy loam	SM, SM-SC	A-2, A-4	>60	---	---	---	Moderate	Low.
	8-38	Sandy clay loam, clay loam.	CL, SC	A-6, A-7						
	38-80	Clay loam, clay	CL	A-6, A-7						
Vingo-----------	0-18	Loamy fine sand	SM	A-2	>60	---	---	---	Moderate	Low.
	18-48	Fine sandy loam	SM, SM-SC	A-2, A-4						
	48-80	Sandy clay loam, fine sandy loam.	SC, SM-SC, CL, CL-ML	A-4, A-6						
22*:										
Manzano---------	0-14	Loam-------------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6						
Alicia----------	0-6	Loam-------------	CL-ML, ML	A-4	>60	---	---	---	High-----	Low.
	6-20	Clay loam, silty clay loam.	CL	A-6						
	20-60	Loam, silt loam, silty clay loam.	CL-ML, CL	A-4, A-6						
Kim-------------	0-6	Loam-------------	ML, SM	A-4	>60	---	---	---	High-----	Low.
	6-60	Loam, clay loam	CL, CL-ML	A-4, A-6						
23*:										
Aridic Argiustolls.										
Rock outcrop.										
24*:										
Colmor----------	0-4	Silt loam--------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	4-32	Silty clay loam, clay loam, silt loam.	CL	A-6						
	32-52	Loam, silt loam	CL-ML, ML	A-4, A-6						
	52-64	Silty clay loam, silt loam.	CL	A-6						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Bedrock: Depth	Bedrock: Hardness	Cemented pan: Depth	Cemented pan: Hardness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
	In				In		In			
				A-4						
24*:										
Swastika--------	0-4	Silt loam--------	CL-ML	A-4, A-6	>60	---	---	---	High-----	Low.
	4-11	Silty clay loam	CL	A-6						
	11-30	Silty clay-------	CL, CH	A-6, A-7						
	30-64	Silty clay loam, clay loam.	CL	A-6						
Kim-------------	0-6	Loam-------------	ML, SM	A-4	>60	---	---	---	High-----	Low.
	6-60	Loam, clay loam	CL, CL-ML	A-4, A-6						
25*:										
Mion------------	0-4	Silty clay loam	CL	A-6	10-20	Soft	---	---	High-----	Low.
	4-14	Silty clay, clay	CL, CH	A-7						
	14	Weathered bedrock	---	---						
Vermejo---------	0-2	Silty clay loam	CL	A-6, A-7	>60	---	---	---	High-----	High.
	2-60	Silty clay, clay	CL, CH	A-7						
Litle-----------	0-3	Silty clay loam	CL	A-6, A-7	20-40	Soft	---	---	High-----	Moderate.
	3-22	Clay, silty clay, silty clay loam.	CL, CH	A-7						
	22	Weathered bedrock	---	---						
26*:										
Raton-----------	0-9	Stony silt loam	CL, CL-ML	A-6, A-4	6-20	Hard	---	---	High-----	Low.
	9-15	Very stony clay, very stony silty clay loam.	CH, CL	A-7						
	15	Unweathered bedrock.	---	---						
Barela----------	0-4	Silt loam--------	ML, CL-ML	A-4	40-60	Hard	---	---	High-----	Low.
	4-12	Silty clay, silty clay loam.	ML, CL	A-6						
	12-31	Stony clay-------	CH, CL	A-7						
	31-41	Very stony clay	CH, CL	A-7						
	41	Unweathered bedrock.	---	---						
27*:										
Morval----------	0-21	Clay loam--------	CL	A-6	>60	---	---	---	Moderate	Low.
	21-57	Silty clay loam, clay loam.	CL	A-6						
	57-60	Gravelly sandy clay loam, very gravelly sandy clay loam.	GC, SC	A-2						
	60-70	Stony clay loam, stony loam.	CL, SC	A-6						
Moreno----------	0-8	Loam-------------	ML, CL-ML	A-4	>60	---	---	---	Moderate	Low.
	8-37	Clay loam, gravelly clay.	CL	A-6, A-7						
	37-60	Gravelly clay, gravelly sandy clay, gravelly clay loam.	CL, CH, SC	A-7, A-2						
Brycan----------	0-12	Very fine sandy loam.	ML	A-4	>60	---	---	---	High-----	Moderate.
	12-37	Sandy clay loam, loam, clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
	37-62	Clay loam, silt loam, sandy clay loam.	CL, CL-ML	A-6, A-4						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hard-ness	Uncoated steel	Concrete
	In				In		In			
28*:										
Bundo-----------	0-30	Gravelly sandy loam.	SM, GM	A-1, A-2	>60	---	---	---	Low------	High.
	30-56	Gravelly loam, very gravelly loam.	GM, SM	A-1, A-2						
	56-80	Very gravelly sandy clay loam.	GC, SC, GP-GC, SP-SC	A-1, A-2						
Angostura-------	0-7	Stony sandy loam	ML, SM	A-2, A-4	>60	---	---	---	Moderate	Moderate.
	7-22	Very stony sandy clay loam, very cobbly sandy clay loam.	SC, GC	A-2, A-6						
	22-60	Very stony sandy clay loam, very gravelly sandy clay loam.	GC, SC	A-2, A-6						
Tolby-----------	0-22	Stony loam-------	ML, SM	A-4	>60	---	---	---	Low------	High.
	22-44	Cobbly loamy sand	SM	A-1						
	44-57	Cobbly sandy loam	SM	A-1, A-2						
	57-80	Cobbly loamy sand	SM	A-1						
29*:										
Burnac----------	0-12	Stony loam-------	ML, CL-ML	A-4	40-60	Hard	---	---	Low------	High.
	12-31	Clay, silty clay, clay loam.	CL, CH	A-7						
	31-53	Gravelly sandy clay.	GC, SC	A-2						
	53	Unweathered bedrock.	---	---						
Fuera-----------	0-15	Cobbly loam------	ML, SM	A-2, A-4	>60	---	---	---	High-----	Low.
	15-31	Clay, cobbly clay	CL, CH	A-7						
	31-58	Stony silty clay, cobbly clay, very cobbly clay.	CL, CH, SC	A-7						
	58-64	Stony clay loam, very cobbly clay, very stony clay.	CL, CH, SC	A-6, A-7						
Hillery---------	0-18	Stony loam-------	ML	A-4	>40	Hard	---	---	High-----	High.
	18-60	Clay, cobbly clay	CH, ML	A-7, A-6						
30*:										
Etoe------------	0-11	Cobbly loam------	SM, GM	A-2, A-4	>60	---	---	---	Low------	Low.
	11-36	Cobbly loam, very cobbly sandy loam, very cobbly loam.	SM, GM	A-2, A-4						
	36-73	Very cobbly sandy clay loam, very stony sandy clay loam, very cobbly loam.	GC, GP-GC, GM-GC	A-1, A-2						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
30*:										
Etown----------	0-18	Very gravelly fine sandy loam.	GM	A-1, A-2	>60	---	---	---	High-----	High.
	18-30	Very cobbly clay loam, very cobbly silty clay loam, very cobbly sandy clay loam.	GC	A-1, A-2						
	30-60	Very cobbly clay, very cobbly sandy clay, very cobbly silty clay.	GC	A-2, A-6, A-7						
Angostura-------	0-7	Stony sandy loam	ML, SM	A-2, A-4	>60	---	---	---	Moderate	Moderate.
	7-22	Very stony sandy clay loam, very cobbly sandy clay loam.	SC, GC	A-2, A-6						
	22-60	Very stony sandy clay loam, very gravelly sandy clay loam.	GC, SC	A-2, A-6						
31*:										
Dargol----------	0-6	Stony loam-------	ML, SM	A-4	20-40	Hard	---	---	Moderate	Moderate.
	6-35	Clay-------------	CH, MH	A-7						
	35	Unweathered bedrock.	---	---						
Fuera-----------	0-15	Cobbly loam------	ML, SM	A-2, A-4	>60	---	---	---	High-----	Low.
	15-31	Clay, cobbly clay	CL, CH	A-7						
	31-58	Stony silty clay, cobbly clay, very cobbly clay.	CL, CH, SC	A-7						
	58-64	Stony clay loam, very cobbly clay, very stony clay.	CL, CH, SC	A-6, A-7						
Vamer-----------	0-4	Stony loam-------	ML, SM	A-4	7-20	Hard	---	---	High-----	Low.
	4-16	Clay-------------	CL, CH	A-7						
	16	Unweathered bedrock.	---	---						
32*:										
Torreon---------	0-6	Silt loam--------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	6-12	Clay loam, silty clay loam.	CL	A-7						
	12-40	Silty clay, clay	CH	A-7						
	40-60	Silty clay loam, clay loam.	CL	A-7						
	60	Weathered bedrock	---	---						
Thunderbird-----	0-2	Clay loam--------	CL	A-7	20-40	Hard	---	---	High-----	Low.
	2-31	Clay, clay loam	CL, CH	A-7						
	31	Unweathered bedrock.	---	---						
Crews-----------	0-5	Loam-------------	CL-ML, CL	A-4, A-6	>60	---	8-20	Thick	High-----	Low.
	5-16	Clay loam, clay	CL, CH	A-6, A-7						
	16	Indurated--------	---	---						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
33*:										
Rednun----------	0-6	Loam-------------	CL-ML, CL	A-4, A-6	>60	---	---	---	High-----	Low.
	6-42	Clay loam, clay	CL, CH	A-6, A-7						
	42-60	Loam, clay loam	CL	A-6						
Carnero---------	0-9	Loam-------------	CL-ML, ML	A-4	20-40	Hard	---	---	High-----	Low.
	9-28	Clay, silty clay, clay loam.	CL, CH	A-6, A-7						
	28	Unweathered bedrock.	---	---						
Tricon----------	0-7	Silt loam--------	CL-ML, CL	A-4, A-6	>60	---	20-40	Thick	High-----	Low.
	7-33	Clay loam, clay, silty clay loam.	CL, CH	A-6, A-7						
	33-39	Gravelly clay loam.	CL, GC	A-6						
	39	Indurated--------	---	---						
34*:										
La Brier--------	0-13	Silt loam--------	ML	A-4, A-6	>60	---	---	---	High-----	Low.
	13-49	Silty clay loam, clay loam, clay.	CL, CH	A-7						
	49-77	Silty clay loam	ML, CL	A-7						
Manzano---------	0-14	Loam-------------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6						
Loma------------	0-5	Loam-------------	ML, CL-ML	A-4	>60	---	---	---	High-----	Low.
	5-28	Silty clay loam, silty clay, clay loam.	CL, CH	A-6, A-7						
	28-60	Silt loam, loam, clay loam.	CL-ML, CL	A-4, A-6						
35*:										
Remunda---------	0-12	Loam-------------	CL-ML, CL	A-4, A-6	>60	---	---	---	High-----	Low.
	12-38	Clay loam, clay	CL, CH	A-7						
	38-60	Clay loam, loam	CL	A-6						
Stroupe---------	0-7	Stony loam-------	SM, ML	A-4	20-40	Hard	---	---	High-----	Low.
	7-24	Stony clay, very stony clay, stony clay loam.	GC, CL	A-6, A-7						
	24	Unweathered bedrock.	---	---						
Crews-----------	0-5	Cobbly loam------	CL-ML, CL	A-4, A-6	>60	---	8-20	Thick	High-----	Low.
	5-16	Clay loam, clay	CL, CH	A-6, A-7						
	16	Indurated--------	---	---						
36*:										
Bernal----------	0-12	Fine sandy loam	SM	A-2, A-4	8-20	Hard	---	---	Moderate	Low.
	12	Unweathered bedrock.	---	---						
Travessilla-----	0-4	Stony loam-------	SM, GM	A-4	6-20	Hard	---	---	Moderate	Low.
	4-8	Loam, channery loam, stony loam.	GM, SM, ML	A-4						
	8	Unweathered bedrock.	---	---						
Crews-----------	0-5	Loam-------------	CL-ML, CL	A-4, A-6	>60	---	8-20	Thick	High-----	Low.
	5-16	Clay loam, clay	CL, CH	A-6, A-7						
	16	Indurated--------	---	---						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hard-ness	Uncoated steel	Concrete
	In				In		In			
37*:										
Apache----------	0-16	Cobbly loam------	CL	A-6	4-20	Hard	---	---	High-----	Low.
	16	Unweathered bedrock.	---	---						
Capulin---------	0-10	Stony loam-------	CL, CL-ML	A-4, A-6	>60	---	---	---	High-----	Low.
	10-41	Clay loam, silt loam, loam.	CL	A-7						
	41-66	Cobbly loam------	CL, CL-ML	A-4, A-6						
Rock outcrop.										
38*:										
Bond------------	0-4	Stony loam-------	CL-ML, GM-GC	A-4	12-20	Hard	---	---	High-----	Low.
	4-17	Sandy clay loam, gravelly sandy clay loam.	SC	A-2, A-6						
	17	Unweathered bedrock.	---	---						
Fortwingate-----	0-13	Stony loam-------	CL-ML	A-4	20-40	Hard	---	---	High-----	High.
	13-23	Sandy clay-------	CL, CH, SC	A-7						
	23-32	Clay, clay loam	CL, CH	A-7						
	32	Unweathered bedrock.	---	---						
39*:										
Rock outcrop.										
Encierro--------	0-5	Stony silty clay loam.	CL	A-6, A-7	10-20	Hard	---	---	High-----	Low.
	5-14	Clay loam, clay, sandy clay.	CL, SC, CH	A-6, A-7						
	14	Unweathered bedrock.	---	---						
Bernal----------	0-12	Loam-------------	CL, SC	A-6	8-20	Hard	---	---	Moderate	Low.
	12	Unweathered bedrock.	---	---						
40*:										
Nambe-----------	0-8	Gravelly loam----	SM, SM-SC	A-1, A-2, A-4	>60	---	---	---	Low------	High.
	8-18	Very stony sandy loam, very cobbly sandy loam.	GM, SM	A-1, A-2						
	18-60	Very stony sandy loam, very cobbly sandy loam.	GM	A-1, A-2						
Cundiyo---------	0-14	Gravelly sandy loam.	GM, SM	A-1, A-2	>60	---	---	---	Low------	High.
	14-46	Very cobbly loam, very cobbly sandy loam.	GM, SM	A-1, A-2						
	46-60	Very cobbly loamy sand.	SM, SP-SM	A-1						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Bedrock: Depth	Bedrock: Hardness	Cemented pan: Depth	Cemented pan: Hardness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
	In				In		In			
41*:										
Gaines----------	0-9	Silty clay loam	CL	A-6, A-7	40-72	Hard	---	---	Moderate	Low.
	9-15	Silty clay loam	CL	A-6, A-7						
	15-32	Silty clay loam, clay loam, clay.	CL, CH	A-7						
	32-48	Very flaggy clay	CL, CH	A-7						
	48	Unweathered bedrock.	---	---						
Hayspur---------	0-5	Loam-------------	CL, CL-ML	A-4, A-6	>60	---	---	---	High-----	Low.
	5-38	Silty clay loam, loam, clay loam.	CL, CL-ML	A-4, A-6						
	38-42	Fine sandy loam	SM, SM-SC	A-4						
	42-60	Very gravelly coarse sand.	GP, GP-GM	A-1						
42*:										
Vermejo---------	0-2	Silty clay loam	CL	A-6, A-7	>60	---	---	---	High-----	High.
	2-60	Silty clay, clay	CL, CH	A-7						
Remunda---------	0-12	Loam-------------	CL-ML, CL	A-4, A-6	>60	---	---	---	High-----	Low.
	12-38	Clay loam, clay	CL, CH	A-7						
	38-60	Clay loam, loam	CL	A-6						
Partri----------	0-4	Loam-------------	CL-ML	A-4	>60	---	---	---	High-----	Low.
	4-29	Clay loam, silty clay loam, clay.	CL	A-7						
	29-60	Gravelly clay loam, cobbly silty clay loam, silty clay loam.	GC, CL, SC, ML	A-7						
43*:										
Pullman---------	0-6	Clay loam--------	CL	A-6, A-7	>60	---	---	---	High-----	Low.
	6-38	Clay, silty clay	CL, CH	A-7						
	38-78	Clay loam, clay, silty clay.	CL	A-6, A-7						
Mansker---------	0-12	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	>60	---	---	---	Moderate	Low.
	12-28	Loam, sandy clay loam, clay loam.	CL, SC	A-4, A-6						
	28-66	Clay loam, sandy clay loam.	CL, SC	A-4, A-6						
Amarillo--------	0-11	Fine sandy loam	SM, SM-SC, CL-ML, ML	A-2, A-4	>60	---	---	---	Moderate	Low.
	11-38	Sandy clay loam, clay loam.	SC, SM-SC, CL	A-4, A-6						
	38-80	Sandy clay loam, clay loam.	SC, CL, SM-SC	A-4, A-6						
44*:										
Mansker---------	0-12	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	>60	---	---	---	Moderate	Low.
	12-28	Loam, sandy clay loam, clay loam.	CL, SC	A-4, A-6						
	28-66	Clay loam, sandy clay loam.	CL, SC	A-4, A-6						
Potter----------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	>60	---	---	---	Moderate	Low.
	9-30	Variable---------	GC, SC, GM-GC, SM-SC	A-2, A-4 A-6, A-2						

See footnote at end of table.

TABLE C-7 -ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hard-ness	Uncoated steel	Concrete
	In				In		In			
45*:										
Bascom----------	0-16	Loam-------------	SM, ML	A-4	>60	---	---	---	High-----	Low.
	16-36	Very gravelly fine sandy loam, very gravelly sandy clay loam, very gravelly loam.	GM	A-1, A-2						
	36-72	Fine sandy loam, loam.	SM, ML	A-4						
Potter----------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	>60	---	---	---	Moderate	Low.
	9-30	Variable---------	GC, SC, GM-GC SM-SC	A-2, A-4, A-6						
Olton-----------	0-8	Loam-------------	CL	A-4, A-6	>60	---	---	---	Moderate	Low.
	8-48	Clay loam, silty clay loam, clay.	CL	A-6, A-7						
	48-80	Clay loam, sandy clay loam, loam.	CL	A-4, A-6, A-7						
46*:										
Amarillo--------	0-11	Fine sandy loam	SM, SM-SC, CL-ML, ML	A-2, A-4	>60	---	---	---	Moderate	Low.
	11-38	Sandy clay loam, clay loam.	SC, SM-SC, CL	A-4, A-6						
	38-80	Sandy clay loam, clay loam.	SC, CL, SM-SC	A-4, A-6						
Ima-------------	0-10	Sandy loam-------	SM	A-2, A-4	>60	---	---	---	High-----	Low.
	10-40	Fine sandy loam, sandy loam.	SM	A-2, A-4						
	40-60	Fine sandy loam, sandy loam, very fine sandy loam.	SM, ML	A-2, A-4						
Bascom----------	0-16	Fine sandy loam	SM, ML	A-4	>60	---	---	---	High-----	Low.
	16-36	Very gravelly fine sandy loam, very gravelly sandy clay loam, very gravelly loam.	GM	A-1, A-2						
	36-72	Fine sandy loam, loam.	SM, ML	A-4						
47*:										
Quay------------	0-9	Loam-------------	ML, CL-ML, CL	A-4	>60	---	---	---	High-----	Low.
	9-26	Clay loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6						
	26-60	Sandy clay loam, clay loam, loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
Montoya---------	0-4	Clay loam--------	CL	A-6, A-7	>60	---	---	---	High-----	Moderate.
	4-60	Clay, silty clay, clay loam.	CL, CH	A-7, A-6						
Lacita----------	0-8	Silt loam--------	ML	A-4	>60	---	---	---	High-----	Low.
	8-72	Silt loam, silty clay loam, clay loam.	CL-ML, CL	A-4, A-6						

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hard-ness	Uncoated steel	Concrete
	In				In		In			
48*:										
Ima-------------	0-10	Sandy loam-------	SM	A-2, A-4	>60	---	---	---	High-----	Low.
	10-40	Fine sandy loam, sandy loam.	SM	A-2, A-4						
	40-60	Fine sandy loam, sandy loam, very fine sandy loam.	SM, ML	A-2, A-4						
Tucumcari-------	0-8	Clay loam---------	CL	A-4, A-6	>60	---	---	---	High-----	Low.
	8-45	Clay loam, silty clay, silty clay loam.	CL, CH	A-6, A-7						
	45-60	Clay loam--------	CL	A-6						
49*:										
Redona----------	0-10	Fine sandy loam	SM	A-2, A-4	>60	---	---	---	Moderate	Low.
	10-60	Sandy clay loam, clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
Canez-----------	0-8	Fine sandy loam	SM, ML	A-4	>60	---	---	---	High-----	Low.
	8-48	Sandy loam, fine sandy loam, sandy clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6						
	48-67	Sandy loam, fine sandy loam, sandy clay loam.	ML, SM	A-4						
Quay------------	0-9	Loam-------------	ML, CL-ML, CL	A-4	>60	---	---	---	High-----	Low.
	9-26	Clay loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6						
	26-60	Sandy clay loam, clay loam, loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
50*:										
Lacita----------	0-8	Silt loam--------	ML	A-4	>60	---	---	---	High-----	Low.
	8-72	Silt loam, silty clay loam, clay loam.	CL-ML, CL	A-4, A-6						
La Lande--------	0-9	Loam-------------	SM, ML	A-4	>60	---	---	---	High-----	Low.
	9-24	Loam, sandy clay loam, clay loam.	CL-ML, CL	A-4, A-6						
	24-60	Loam, sandy clay loam.	CL-ML, CL	A-4						
Quay------------	0-9	Loam-------------	ML, CL-ML, CL	A-4	>60	---	---	---	High-----	Low.
	9-26	Clay loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6						
	26-60	Sandy clay loam, clay loam, loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
51*:										
Latom-----------	0-8	Stony sandy loam	SM, SM-SC	A-2, A-4	4-20	Soft	---	---	Low------	Low.
	8	Unweathered bedrock.	---	---						
Rock outcrop.										

See footnote at end of table.

TABLE C-7-ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Bedrock		Cemented pan		Risk of corrosion	
			Unified	AASHTO	Depth	Hardness	Depth	Hardness	Uncoated steel	Concrete
	In				In		In			
52*:										
Tucumcari	0-8	Clay loam	CL	A-4, A-6	>60	---	---	---	High	Low.
	8-45	Clay loam, silty clay, silty clay loam.	CL, CH	A-6, A-7						
	45-60	Clay loam	CL	A-6						
Montoya	0-4	Clay loam	CL	A-6, A-7	>60	---	---	---	High	Moderate.
	4-60	Clay, silty clay, clay loam.	CL, CH	A-7, A-6						
Redona	0-10	Fine sandy loam	SM	A-2, A-4	>60	---	---	---	Moderate	Low.
	10-60	Sandy clay loam, clay loam.	SM-SC, SC, CL-ML, CL	A-4, A-6						
53*:										
Carnero	0-9	Loam	CL-ML, ML	A-4	20-40	Hard	---	---	High	Low.
	9-28	Clay, silty clay, clay loam.	CL, CH	A-6, A-7						
	28	Unweathered bedrock.	---	---						
Rednun	0-6	Loam	CL-ML, CL	A-4, A-6	>60	---	---	---	High	Low.
	6-42	Clay loam, clay	CL, CH	A-6, A-7						
	42-60	Loam, clay loam	CL	A-6						
Bernal	0-12	Loam	CL, SC	A-6	8-20	Hard	---	---	Moderate	Low.
	12	Unweathered bedrock.	---	---						
54*:										
Chimayo	0-6	Stony loam	ML, SM	A-4, A-2	12-20	Hard	---	---	Low	Low.
	6-20	Very stony loam, very stony sandy loam.	ML, SM	A-4, A-2						
	20	Unweathered bedrock.	---	---						
Mirabal	0-5	Stony loam	SM, GM	A-1, A-2	20-35	Hard	---	---	Low	Moderate.
	5-23	Stony sandy loam, stony loam.	SM, GM	A-1, A-2						
	23	Unweathered bedrock.	---	---						
Supervisor	0-10	Gravelly sandy loam.	SM	A-1, A-2	20-40	Hard	---	---	Low	High.
	10-16	Gravelly loam, very gravelly sandy loam, stony sandy loam.	SM, GM	A-1, A-2						
	16-22	Stony sandy loam, very stony sandy loam, gravelly loam.	SM	A-2, A-4						
	22	Unweathered bedrock.	---	---						

* See description of the map unit for composition and behavior characteristics of the map unit.

SOIL ASSOCIATIONS

Pecos - Canadian Plains and Valleys (CP)
Land Resource Area

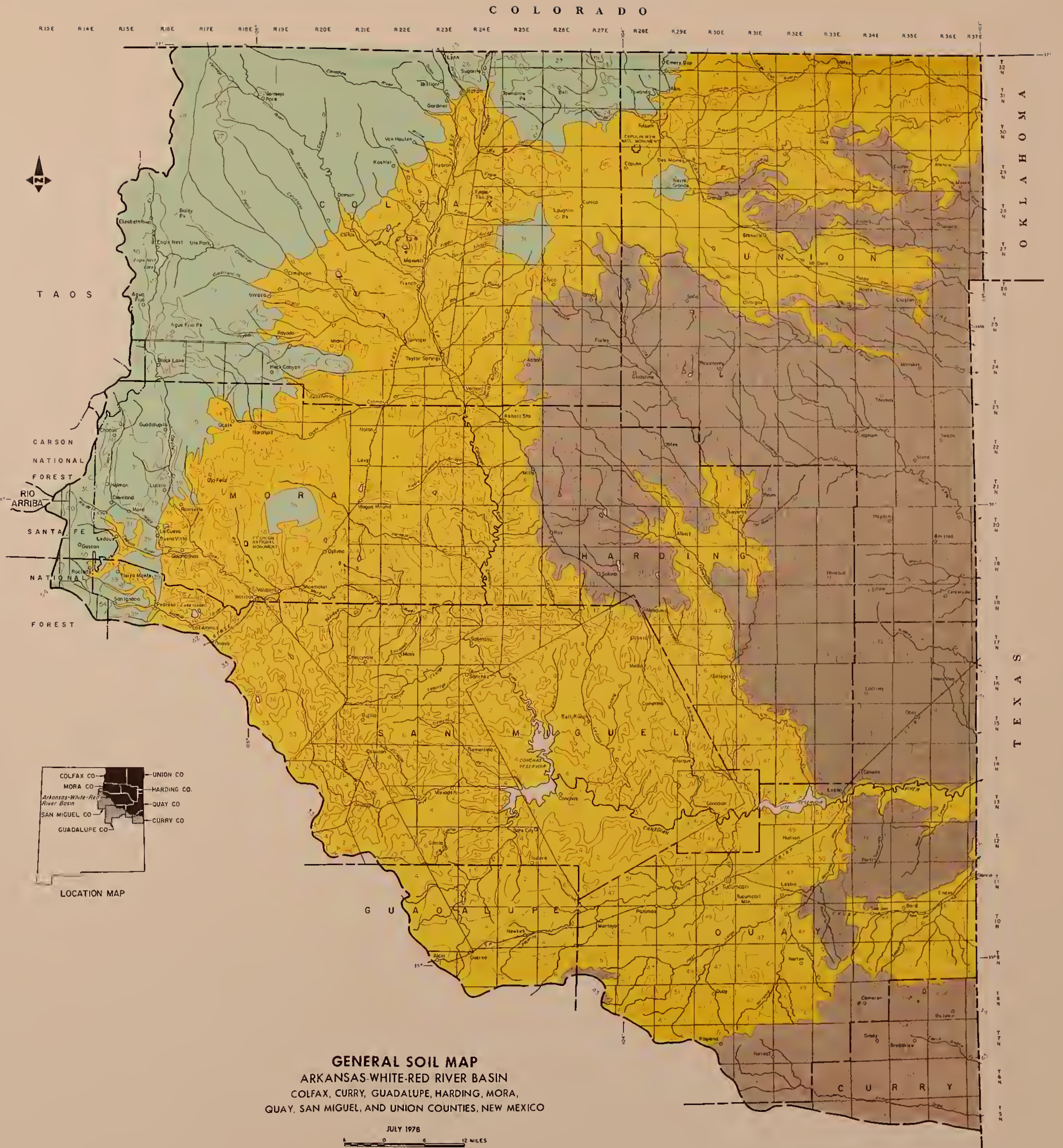
2. Lacita-Redona-Quay association
4. Conchas-Latom association
5. Redona-Bascom association
6. Rock Outcrop-Orthents-Ustolls association
7. Gruver-La Brier-Dumas association
8. Litle-Berthoud-Penrose association
9. Berthoud-Kinkead association
12. Mansker-Portales association
13. Otero-Dalhart association
14. Amarillo-Springer association
15. Springer-Tivoli-Amarillo associaton
16. Apache-Torreon-Tricon association
17. Travessilla-Carnero-Rock Outcrop association
18. Gallegos association
19. Spurlock-Texline association
20. Colmor-Litle association
22. Manzano-Alicia association
24. Colmor-Swastika association
25. Mion-Vermejo-Litle association
32. Torreon-Thunderbird-Crews association
33. Rednun-Carnero-Tricon association
34. La Brier-Manzano-Loma association
35. Remunda-Stroupe-Crews association
36. Bernal-Travessilla-Crews association
37. Apache-Capulin association
38. Bond-Fortwingate association
39. Rock Outcrop-Encierro-Bernal association
42. Vermejo-Remunda association
45. Bascom-Potter-Olton association
47. Quay-Montoya-Lacita association
48. Ima-Tucumcari association
49. Redona-Canez association
50. Lacita-La Lande-Quay association
51. Latom-Rock Outcrop association
52. Tucumcari-Montoya association
53. Carnero-Rednun-Bernal association

Southern Rocky Mountain (RM)
Land Resource Area

16. Apache-Torreon-Tricon association
23. Aridic Argiustolls-Rock Outcrop association
24. Colmor-Swastika association
26. Raton-Barela association
27. Morval-Moreno-Brycan association
28. Bundo-Angostura-Tolby association
29. Burnac-Fuera-Hillery association
30. Etoe-Etown-Angostura association
31. Dargol-Fuera-Vamer association
34. La Brier-Manzano-Loma association
38. Bond-Fortwingate association
39. Rockland-Encierro-Bernal association
40. Nambe-Cundiyo association
41. Gaines-Hayspur association
42. Vermejo-Remunda association
54. Chimayo-Mirabal-Supervisor association

Southern High Plains (HP)
Land Resource Area

3. San Jon-Los Tanos-Ima association
6. Rock Outcrop-Orthents-Ustolls association
7. Gruver-La Brier-Dumas association
9. Berthoud-Kinkead association
10. Church-Karde association
11. Campus-Dean association
12. Mansker-Portales association
13. Otero-Dalhart association
14. Amarillo-Springer association
15. Springer-Tivoli-Amarillo association
16. Apache-Torreon-Tricon association
17. Travessilla-Carnero-Rock Outcrop association
19. Spurlock-Texline association
20. Colmor-Litle association
21. Dallam-Rickmore association
43. Pullman-Mansker-Amarillo association
44. Mansker-Potter association
45. Bascom-Potter-Olton association
46. Amarillo-Ima association
47. Quay-Montoya-Lacita association



GENERAL SOIL MAP
ARKANSAS-WHITE-RED RIVER BASIN
COLFAX, CURRY, GUADALUPE, HARDING, MORA,
QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

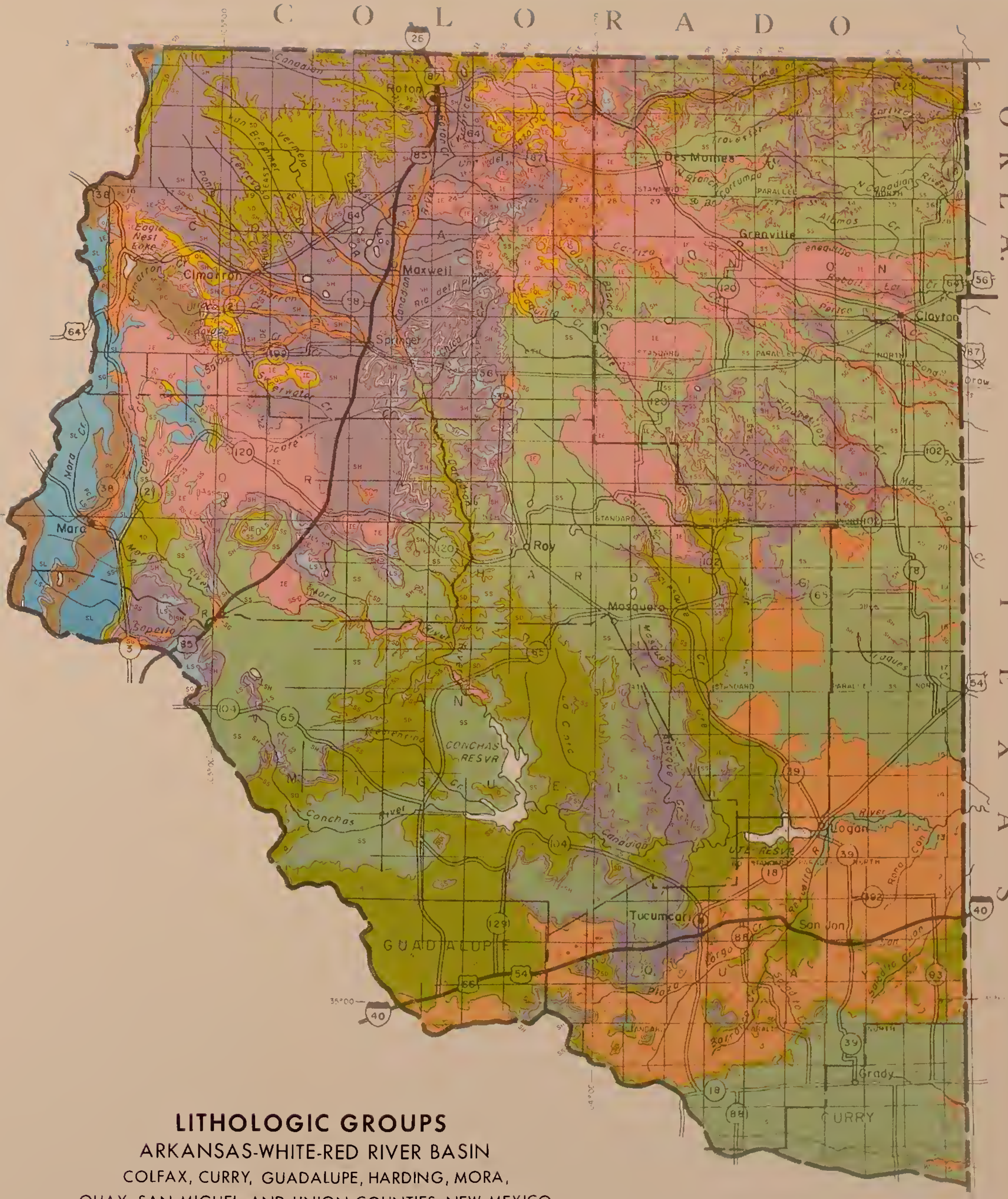
JULY 1978

SCALE 1:1,200,000

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:500,000 series.
Thematic detail compiled by state staff.
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

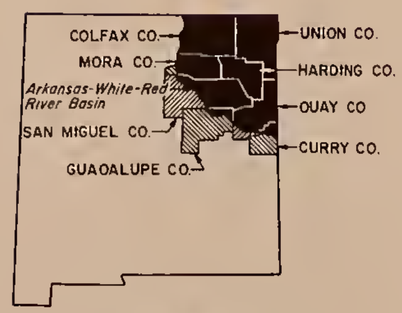
USDA-SCS-PORTLAND OR 1979

M7-SN-23626-1



LEGEND

- PC Precombrian Rocks
- SG Quaternary & Tertiory Sonds & Grovels
- QL Landslide Deposits
- TE Volcanic Rocks
- SS Sandstane
- SH Shales
- LS Limestone
- SD Sandstone & Shale
- SL Sandstone & Limestane



LOCATION MAP

LITHOLOGIC GROUPS

ARKANSAS-WHITE-RED RIVER BASIN

COLFAX, CURRY, GUADALUPE, HARDING, MORA, QUAY, SAN MIGUEL, AND UNION COUNTIES, NEW MEXICO

JULY 1978

10 0 10 20 MILES

SCALE 1:1,200,000

Source:
Base map prepared by SCS, Portlond Corto. Unit from USGS 1:1,000,000 Notional Atlos. Themotic detail compiled by state stoff from Geologic Map of New Mexico by Corle H. Dane ond George O. Bachman, 1965 U.S. Dept. of Interior Geological Survey.

U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1978

M7-EN-22828-12

APPENDIX D

FISH AND WILDLIFE

APPENDIX D - FISH AND WILDLIFE

MAMMALS

OCCURRENCE

Deer

The mule deer is the most common big game species, supports the largest hunter pressure, and provides the largest harvest. Mule deer use a wide range of habitat types, although not all available range is currently occupied.

Table D-1 reflects the available deer habitat and land open to public hunting, expressed as percent of total land area within the unit.

TABLE D-1 - AREA OF DEER HABITAT AND PERCENTAGE OF TOTAL AREA, SQUARE MILES, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Game Management Units	Total Area	Year-round Range	Summer Only Range	Winter Only Range	Area Open to Public Hunting and Percentage of Total Area
1	1976	1092 (55%)	588 (30%)	0	423 (21%)
2	1731	346 (20%)	87 (3%)	0	388 (22%)
3	1301	442 (34%)	332 (26%)	331 (25%)	19 (1.5%)
20	2159	778 (36%)	518 (24%)	0	1239 (60%)
21	5840	876 (15%)	0	0	650 (11%)
22	3701	74 (2%)	0	0	965 (26%)
35	2300	920 (40%)	0	0	270 (11%)

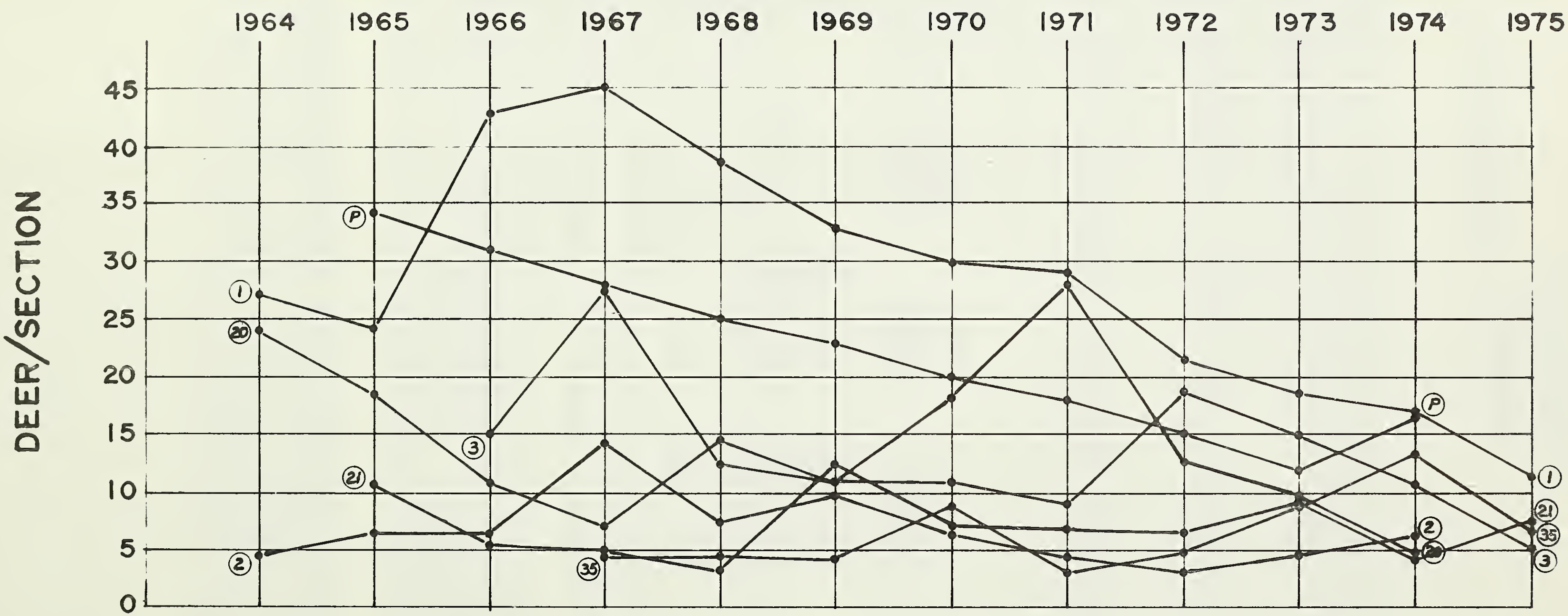
Source: Project 14-93-R-20, "Game Surveys", New Mexico Department of Game and Fish.

Mule deer populations have been trending strongly downward. The significance of this downward population trend is apparent from field-gathered population data (Figure D-1).

Elk

There are two distinct populations of elk which occur within the area. There are the resident herds which, while occurring throughout the range, tend to dominate the southerly portions. Winter migration brings herds from Colorado onto ranges of the Cimarron Mountains and easterly through Vermejo Park to Raton. Both populations have been increasing in recent years.

SPRING POPULATIONS OF MULE DEER



21 = Game Management Unit No. 21, etc.

P = Philmont Scout Ranch

Data based on Pellet Group Transects

FIGURE D-1

Pronghorn Antelope

Antelope are found primarily on the great expanses of open rangeland, which is largely privately owned. Conditions of the rangeland, as influenced by weather and livestock management, are very closely related to the well-being of herds of antelope. Antelope populations may fluctuate widely over periods of just a few years.

Rocky Mountain Bighorn Sheep

Bighorns were released on the Colin Neblett Wildlife Area along Cimarron Canyon. Reports have indicated that a small herd has been observed as far south as Ocate, as well as north on Touchmenot and Baldy Mountains. Bighorns are not hunted within the basin.

Barbary Sheep

This exotic sheep has been successfully established along the gorge of the Canadian River. Apparently able to compete effectively with mule deer and livestock, the barbary has been hunted since 1955.

Siberian Ibex

Releases of ibex into the Canadian River gorge were made during the winter of 1975-76. It is anticipated that this population will increase and in time provide public hunting.

Bear

Bears are surprisingly common throughout all suitable ranges of the basin. Populations have been increasing in recent years.

Mountain Lion

The lion had been considered a predatory species, without legal protection, until 1971 when legislative action designated it as a game species. Research has been started to provide the life history and population information needed to plan management and harvest strategies.

FISH AND FISH HABITAT

OCCURRENCE

The major associations of fish species are described in terms of habitat dependence; i.e., warm and cold waters, lake and stream.

1. Warm water lakes commonly support large mouth bass, crappie, bluegill, and channel catfish. The walleye and northern pike have successfully been introduced into several warm water lakes. Carp, carpsucker and many minnow species are major components of the waters.

2. Cold water lakes commonly support rainbow, brook, and cutthroat trout, white sucker and creek chub. There will usually be representatives of warm water species in lakes at lower elevations.

3. Warm water streams commonly support channel catfish, black bullhead, flathead chub, Arkansas river shiner, and other minnow species.

4. Cold water streams commonly support rainbow, brook, brown, or cutthroat trout which occur as varying mixed populations in response to habitat conditions as well as stocking history. These streams also support the white sucker, longnose dace and other minnow species.

TABLE D-2 MAJOR RIVER AND STREAM FISH HABITAT OF THE ARKANSAS-WHITE-RED RIVER BASIN

River or Stream	Length	Suitable Fish Habitat	Available to Public	Type of Fishery
	-----	Miles	-----	
AWR Basin				
Canadian River	250	80	66	warm water
Cimarron River	90	30	20	trout
Dry Cimarron River	90	5	5	trout
Ute Creek	100	10	0	warm water
Colfax County				
Chicorico Creek	30	6	6	trout
Clear Creek	5	5	5	trout
Ponil Creek	50	10	2	trout
Rayado Creek	60	20	0	trout
Tolby Creek	7	4	4	trout
Vermejo River	70	15	0	trout
Mora County				
Aqua Fria Creek	9	7	4	trout
Coyote Creek	40	20	9	trout
Gascon Creek	6	6	6	trout
Lujan Creek	9	9	9	trout
Luna Creek	7	7	7	trout
Mora River	130	30	16	trout
Ocate Creek	60	5	0	trout
Rio La Casa	15	11	4	trout
San Miguel County				
Conchas River	50	5	0	warm water
Daily Canyon	7	7	7	trout
Maestas Creek	8	4	3	trout
Manuelitas Creek	20	20	17	trout
Sapello Creek	60	20	14	trout

Source: Fisheries Survey of the Canadian and Cimarron Rivers Drainge in New Mexico, New Mexico Game and Fish Department, 1956.

TABLE D-3 MAJOR LAKE FISH HABITAT OF THE ARKANSAS-WHITE-RED RIVER BASIN

Lake or Reservoir	When Full	Available to Public	Private	Type of of Fishery
	-----------------	Acres	-----------------	
Colfax County				
Armstrong Lake	4	-	4	trout
Cimarron Gravel Pits	2	2	-	trout
Cimarron Reservoir	20	-	20	trout
Cimarroncito Lake	10	-	10	trout
Eagle Nest Lake	1400	-	1400	trout
Industrial School Lake	3	3	-	trout
Jaritas Lake	8	-	8	trout
Lake Alice	5	5	-	trout
Lake Maloya	123	123	-	trout
Laguna Madre	410	410	-	trout
Maxwell Lake #2	400	400	-	warm water
Maxwell Lake #13	316	316	-	warm water
Maxwell Lake #14	120	120	-	trout
Miami Lake	150	150	-	warm water
Springer Lake	500	500	-	trout & warm water
Stubblefield Lake	1210	1210	-	trout
Throttle Reservoir	90	-	90	warm water
Wilson Mesa Lakes	4	4	-	trout
Vermejo Park Lakes	180	-	180	trout
Harding County				
Black Lake	200	-	200	warm water
Chicosa Lake	30	30	-	trout
Mora County				
Charette Lakes	393	393	-	warm water
Colley Lake	250	-	250	warm water
Encantanda Lake	5	5	-	trout
La Cueva Lake	516	-	516	warm water
Laguna Linda	10	-	10	trout
Mossman Reservoir	9	-	9	warm water
Morphy Lake	40	40	-	trout
North Fork Lake	2	2	-	trout
Pacheco Lake	5	-	5	trout
Riner Lake	20	-	20	warm water

TABLE D-3 (Continued)

	When Full	Available to Public	Private	Type of of Fishery
	Acres			
San Miguel County				
Conchas Lake	10,000	10,000	-	warm water
Maestas Lake	3	-	3	trout
Quay County				
Ute Lake	4,100	4,100	-	warm water
Union County				
Clayton Lake	90	90	-	trout
Pasamonte Lake	50	-	50	warm water
Snyder Lake	30	-	30	warm water

Source: Fisheries Survey of the Canadian and Cimarron Rivers Drainages in New Mexico, New Mexico Game and Fish Department, 1956.

PRODUCTION

Fisheries production can be expressed as the amount of recreational opportunity provided as well as in the more common terms of pounds of fish produced and harvest rates.

Estimates of standing crops of fish produced in typical habitats within the basin are not available. However, in general terms, the larger, downstream warm water impoundments are very productive. The smaller headwater streams and the cold water lakes at higher elevations are less productive.

Fishing pressure on waters available to the public and receiving management by the New Mexico Department of Game and Fish has been described in Statewide Fisheries Investigations, F-22R-14, Job No. A-1, "Basic Surveys", May 1974.

Some representative values are:

Dry Cimarron River - 127 angler hours/acre/year
Mora River - 241 angler hours/acre/year
Sapello Creek - 50 angler hours/acre/year
Cimarron River - 1214 angler hours/acre/year
Conchas Lake - 22 angler hours/acre/year
Ute Lake - 73 angler hours/acre/year
Canadian River - 10 angler hours/acre/year
Clayton Lake - 119 angler hours/acre/year

During the period of April 1 through September 30, 1973, intensive angler use checks were made at Lake Maloya near Raton. See Statewide Fisheries

Investigations, F-22-R-14, Job No. K-1, "Creel Census - Lakes and Streams", 6/74. Data indicate that this 123 acre lake, which received stockings of 9,830 trout, supported almost 15,000 angler visits of which one-third occurred on weekends or holidays. The average angler caught 0.48 fish for each hour spent fishing.

Statewide catch rates on trout waters were 0.33 and 0.42 fish per hour in 1973 and 1972. For comparison, 1973 catch rates within the basin were: Cimarron River - 0.39; Mora River - 0.49; Chicorico Creek - 1.33; Lake Alice - 0.27; and Clayton Lake - 0.19.

Statewide catch rates on warm waters were 0.28 and 0.36 fish per hour in 1973 and 1972. For comparison, 1973 catch rates within the basin were: Miami Lake - 0.60; Springer Lake - 0.30; Conchas Lake - 0.20; and Ute Lake - 0.92.

There are no commercial fish hatcheries located within the basin.

BIRDS

OCCURRENCE

The abundance of bird populations may not be a very reliable index for use in judging the quality of habitats. For example, densities of eight breeding species in an Arizona ponderosa pine forest varied by 55.4 percent (42.8 percent to 80.0 percent) in two consecutive years.

Some available studies indicated the following:

TABLE D-4 BREEDING BIRD DENSITIES & STANDING CROPS AT IBP GRASSLAND PLOTS, 1970

Site	Species	Number per square mile Density		Standing Crop	
		Grazed	Ungrazed	Grazed	Ungrazed
Pantex site (shortgrass Texas Panhandle)	Horned Lark	196.7	120.2	63.3	38.7
	Meadowlark	49.8	70.6	49.1	69.6
	Lark Bunting	2.9	1.9	1.0	0.7
	Grasshopper Sparrow	17.0	19.4	2.9	3.3
		266.3	212.1	116.3	112.3
		Heavy Winter	Light Winter	Heavy Winter	Light Winter
Pawnee Site (shortgrass - NE Colorado)	Horned Lark	66.7	61.8	21.5	19.9
	Meadowlark	27.2	29.4	28.5	51.8
	Lark Bunting	69.2	74.1	26.0	27.9
	Brewer's Sparrow	24.7	56.8	2.8	6.4
		187.8	242.2	78.8	108.4
Jornada Site (desert grassland - Southern NM)		Grazed	Ungrazed	Grazed	Ungrazed
	Scaled Quail	1.9	-	3.8	-
	Mockingbird	13.2	6.6	6.6	1.0
	Loggerhead Shrike	4.7	-	2.3	-
	Ash-throated Flycatcher	-	7.5	-	2.1
	Cactus wren	-	0.9	-	0.3
	Western Kingbird	-	3.8	-	1.4
		19.8	18.8	12.7	4.8

Source: Patterns & Process in Grassland Bird Communities, John A. Wiens, Ecological Monographs 43, 1973.

TABLE D-5 BREEDING BIRD SURVEYS SIX YEAR AVERAGES (1968-1974)

Species Observed Per Route

Stratum (after Kuchler)	Number Species
Colorado Plateau & Canyonland	20.1
Southern Rocky Mountains	44.4
Mexican Highlands	35.9
Pinon-Juniper Woodland	38.2
Staked Plains - Pecos Valley	25.1
High Plains	32.7

Source: U. S. Fish and Wildlife Service, Administrative Report

TABLE D-6 GOLDEN EAGLE WINTER POPULATIONS

Year	East Central NM	: Texas West	:Colorado	:Utah	:Wyoming
1963-1964	386				
1969-1970	1100	200			
1970-1971	915				
1971-1972	700		1886	529	2116

Source: 1. Winter Golden Eagle Populations in Southwest, Boeker & Boeker, 1972.
2. Status of Golden Eagle Surveys in the Western States, E. L. Boeker, 1974.

Winter golden eagle populations in eastern New Mexico range from four eagles per hundred square miles in low years to nine eagles per hundred square miles in peak years. An all season ground study made in 1971-1972 showed 2.6, 0.4, 5.3, 8.0, and 16.7 eagles per thousand miles driven in east central New Mexico, west Texas, Colorado, Utah, and Wyoming, respectively.

Bobwhite quail populations exist throughout the irrigated areas along the extreme eastern border. While numbers fluctuate widely, an estimate made in 1973 (Snyder, 1973) indicates an average of 25 birds per square mile of occupied habitat.

This part of the state has never been know to support large flocks of turkey. Scattered flocks occur and are most numerous in the Cimarron, Ocate, and Mora areas in the ponderosa pine associations. Fluctuations in the number of turkeys are associated with the availability of grass seed heads and mast during the winter months, as well as patterns and amounts of winter and spring precipitation.

TABLE D-7 WATERFOWL DAYS OF USE AT MAXWELL NATIONAL WILDLIFE REFUGE

	July-Sept 74	Oct-Dec 74	Jan-March 75	March-June 75	12 month Total
Total Swans (1 sp.)	0	30	0	0	30
Total Geese (2 sp.)	480	158,160	29,100	2,160	189,900
Total Ducks (16 sp.)	310,080	507,090	131,700	109,710	1,058,580
Total waterfowl	485,640	1,095,780	195,000	168,510	1,944,990
Waterfowl production - 143 ducks of 4 species					

Source: U. S. Fish and Wildlife Service, Birds of the Maxwell National Wildlife Refuge, 1972.

TABLE D-8 LA CUEVA AND WAGON MOUND REFUGES - WATERFOWL OCCURRENCE

Date	La Ceuva	Wagon Mound
Oct. 1975	-	2,000 ducks
Nov. 1975	-	500 ducks 18 geese
Dec. 1975	32,400 geese 1,535 ducks	Frozen - 0
Jan. 1976	-	Frozen - 0

Source: Data supplied by New Mexico Game and Fish Department

PRODUCTS

Birds generate both economic and recreational values. Included as economic values are the obvious influences of resident and out-of-state hunters who come to the AWR Basin to hunt game birds and waterfowl. Less obvious are the economic values associated with the nonconsumptive enjoyment of birdwatching - travel and lodging, film, binoculars, bird identification guides, birdseed, etc.

The biological roles of birds produce some values from their feeding activities. Consumption of insects and rodents may be considered beneficial, while bird predation on livestock, game animals and game fish is viewed as adverse to human interests, as is crop depredation.

The esthetic values which man perceives in the beauty and song of birds have been historically chronicled in literature, music, and art.

TABLE D-9 ESTIMATED GAME BIRD HUNTING PRESSURE AND SUCCESS

	Colfax	Union	Harding	Mora	San Miguel	Quay	Guadalupe
Duck Hunters	73.	13.		34.	93.	180.	23.
Duck Harvest	517.	25.		84.	568.	1435	536.
Average Bag (5.5 trips)	7.1	1.9		2.5	6.1	8.0	3.3
Goose Hunters	93.	7.	7.	47.	80.	120.	-
Goose Harvest	270.	53.	8.0	225.	75.	225.	-
Average Bag (3.7 trips)	2.9	7.6	1.1	4.8	0.9	1.9	-
Grouse Hunters	49.	-	-	63.	112.	-	-
Grouse Harvest	85.	-	-	79.	72.	-	-
Average Bag (2.5 trips)	1.7	-	-	1.3	0.6	-	-
Pheasant Hunters	80.	20.	-	33.	7.	241.	-
Pheasant Harvest	74.	20.	-	0.	0.	290.	-
Average Bag (1.5 trips)	0.9	1.0	-	0.	0.	1.2	-
Quail Hunters	33.	80.	47.	73.	87.	640.	67.
Quail Harvest	126.	1128.	324.	753.	187.	7578.	729.
Average Bag (6.6 trips)	3.8	14.1	10.9	10.3	2.1	11.8	10.9
Dove Hunters	133.	27.	27.	60.	113.	292.	40.
Dove Harvest	2036.	175.	190.	779.	738.	2546.	409.
Average Bag (6.5 trips)	15.3	6.5	7.0	13.0	6.5	8.7	10.2

Source: 1973-1974 Season Data from PR Project W-104-R-14, Work Plan II, Job 1, "Game Bird Studies", NM Department of Game and Fish

BIRDS OF THE AWR RIVER BASIN

* Indicates species which breed in the area

LOON, GREBES, CORMORANTS, PELICAN

COMMON LOON

Horned Grebe
Eared Grebe
Western Grebe
Pied-billed Grebe
Double-crested Cormorant
White Pelican

SWANS, GEESE, DUCKS

Whistling Swan
*Canada Goose
White-fronted Goose
Snow Goose
*Mallard
*Gadwall
*Pintail
*Green-winged Teal
*Blue-winged Teal
*Cinnamon Teal
American Widgeon
Shoveler
Wood Duck
Red Head
Ring-necked Duck
*Canvasback
Greater Scaup
Lesser Scaup
Common Goldeneye
Bufflehead
Ruddy Duck
Red-breasted Merganser
*Common Merganser

QUAIL, PHEASANT, TURKEY

*Scaled Quail
*Bobwhite Quail
*Ring-necked Pheasant
*Turkey

HERONS, BITTERNS, IBIS

*Great Blue Heron
Green Heron
Little Blue Heron
Black-crowned Night Heron
Yellow-crowned Night Heron
Snowy Egret
Least Bittern
American Bittern
White-faced Ibis

VULTURES, HAWKS, EAGLES

*Turkey Vulture
Mississippi Kite
Goshawk
Sharp-shinned Hawk
Cooper's Hawk
*Red-tailed Hawk
*Swainson's Hawk
Rough-legged Hawk
*Ferruginous Hawk
*Golden Eagle
Bald Eagle
*Marsh Hawk
Osprey
*Prairie Falcon
Peregrine Falcon
*Sparrow Hawk
Pigeon Hawk

GROUSE

*Blue Grouse
*White-tailed Ptarmigan
*Lesser Prairie Chicken

CRANES, RAILS, COOTS

Sandhill Crane
Virginia Rail
Sora
Common Gallinule
*American Coot

SHOREBIRDS, GULLS, TERNS

*Killdeer
Black-bellied Plover
*Mountain Plover
Common Snipe
*Long-billed Curlew
*Upland Plover
*Spotted Sandpiper
Solitary Sandpiper
Willet
Greater Yellowlegs
Lesser Yellowlegs
Pectoral Sandpiper
White-rumped Sandpiper
Baird's Sandpiper
Least Sandpiper
Long-billed Dowitcher
Stilt Sandpiper
Western Sandpiper
Marbled Godwit
Sanderling
*American Avocet
*Black-necked Stilt
Wilson's Phalarope
Northern Phalarope
Herring Gull
Ring-billed Gull
Franklin's Gull
Bonaparte's Gull
Forsters' Tern
Black Tern

HUMMINGBIRDS

*Black-chinned Hummingbird
*Broad-tailed Hummingbird
Rufous Hummingbird
Calliope Hummingbird

WOODPECKERS

Yellow-shafted Flicker
*Red-shafted Flicker
*Red-headed Woodpecker
*Lewis' Woodpecker
*Yellow-bellied Sapsucker
*Williamson's Sapsucker
*Hairy Woodpecker
*Downy Woodpecker
*Ladder-backed Woodpecker
*Northern Three-toed Woodpecker

DOVES, PIGEONS

*Mourning Dove
*Band-tailed Pigeon
*Rock Dove (Domestic Pigeon)

ROADRUNNER, CUCKOOS

*Roadrunner
*Yellow-billed Cuckoo

OWLS

*Barn Owl
*Screech Owl
Flammulated Owl
Great Horned Owl
*Burrowing Owl
Spotted Owl
*Long-eared Owl
Short-eared Owl
Saw-whet Owl

GOATSUCKERS

*Common Nighthawk
*Poor-will

SWIFTS

Black Swift
Chimney Swift
*White-throated Swift

KINGFISHERS

Belted Kingfisher

FLYCATCHERS

*Eastern Kingbird
*Western Kingbird
*Cassin's Kingbird
*Scissor-tailed Flycatcher
Great-crested Flycatcher
*Ash-throated Flycatcher
*Eastern Phoebe
*Say's Phoebe
Traill's Flycatcher
*Western Wood Peewee
*Olive-sided Flycatcher
*Vermilion Flycatcher

LARKS

*Horned Lark

JAYS, MAGPIES, RAVENS AND CROWS

*Gray Jay
Blue Jay
*Steller's Jay
*Scrub Jay
*Black-billed Magpie
*Common Raven
*White-necked Raven
*Common Crow
Pinyon jay
*Clark's Nutcracker

CHICKADEES, TITMICE, NUTHATCHES AND CREEPERS

*Black-capped Chickadee
*Mountain Chickadee
*Plain Titmouse
*Common Bushtit
*White-breasted Nuthatch
*Red-breasted Nuthatch
*Pygmy Nuthatch
Brown Creeper

THRUSHES AND BLUEBIRDS

*Robin
*Hermit Thrush
Swainson's Thrush
*Townsend's Solitaire
*Mountain Bluebird
*Western Bluebird
Eastern Bluebird

PIPITS, WAXWINGS, SHRIKES AND STARLINGS

*Water Pipit
Sprague Pipit
Bohemian Waxwing
Cedar Waxwing
Northern Shrike
*Loggerhead Shrike
*Starling

SWALLOWS

*Violet-green Swallow
*Tree Swallow
Bank Swallow
Rough-winged Swallow
*Barn Swallow
*Cliff Swallow

DIPPER

*Dipper

WRENS

*House Wren
*Bewick's Wren
Long-billed Marsh Wren
*Canyon Wren
*Rock Wren

MOCKINGBIRDS AND THRASHERS

*Mockingbird
*Catbird
*Brown Thrasher
*Curve-billed Thrasher
Sage Thrasher

GNATCATCHERS AND KINGLETS

*Blue-gray Gnatcatcher
*Golden-crowned Kinglet
*Ruby-crowned Kinglet

VIREOS

*Gray Vireo
Solitary Vireo
*Warbling Vireo

MEADOWLARKS, BLACKBIRDS AND ORIOLES

*House Sparrow
*Meadowlark
Yellow-headed Blackbird
*Red-winged Blackbird
*Brewers' Blackbird
*Common Grackle
Boat-tailed Grackle
*Brown-headed Cowbird
*Bullock's Oriole

TANAGERS

*Western Tanager

GROSBEAKS, FINCHES, SPARROWS, BUNTINGS

Rose-breasted Grosbeak
*Black-headed Grosbeak
*Blue Grosbeak
Indigo Bunting
Lazuli Bunting
Dickcissel
*Evening Grosbeak
Cassin Finch
*House Finch
Pine Grosbeak
Gray-crowned Rosy Finch
Black Rosy Finch
Brown-capped Rosy Finch
Pine Siskin
*Lesser Goldfinch
Red Crossbill
*Green-tailed Towhee
*Rufous-sided Towhee
*Brown Towhee
*Lark Bunting
Savannah Sparrow
Grasshopper Sparrow
Baird's Sparrow
*Vesper Sparrow
*Lark Sparrow
*Rufous-crowned Sparrow
*Cassin's Sparrow
Black-throated Sparrow
Sage Sparrow
White-winged Junco
Slate-colored Junco
Oregon Junco
*Grey-headed Junco
*Tree Sparrow
*Chipping Sparrow
Clay-colored Sparrow
*White-crowned Sparrow
White-throated Sparrow
Fox Sparrow
*Lincoln's Sparrow
*Song Sparrow
McCown Longspur
Chestnut-collared Longspur

WOOD WARBLERS

*Orange-crowned Warbler
Virginia's Warbler
*Yellow Warbler
Black and White Warbler
Nashville Warbler
Myrtle Warbler
*Audubon's Warbler
Black-throated Gray Warbler
Townsend's Warbler
Grace Warbler
Northern Waterthrush
*MacGillivray's Warbler
*Yellowthroat
*Yellow-breasted Chat
Wilson's Warbler
American Redstart

Sources:

1. Check-list of the Birds of New Mexico, John P. Hubbard, New Mexico Ornithological Society Publication No. 3, 1970.

2. Birds of the Kiowa National Grassland, Forest Service, 1973.

3. Birds of the Comanche National Grassland, Forest Service, 1970.

4. Birds of the Maxwell National Wildlife Refuge, Fish and Wildlife Service, 1972.

AMPHIBIANS AND REPTILES

There is no evidence of significant economic exploitation of the herpetofauna. Commercial collection of water dogs for fishing bait probably occurs at private ponds.

The production of snakes and lizards on the vast grasslands is an important element in the food chains of avian predators.

Biological monitoring of rangelands treated with toxiphene for range caterpillar control suggests that lizard and snake populations are severely decimated within sprayed areas.

OCCURRENCE OF AMPHIBIANS AND REPTILES IN THE AWR RIVER BASIN

SALAMANDERS

Tiger salamander

FROGS AND TOADS

Canyon tree frog
Chorus frog
Leophard frog
Plains spadefoot toad
Great plains toad
Green toad
Red-spotted toad
Woodhouse's toad

SNAKES

Glossy snake
Western diamondback rattlesnake
Prairie rattlesnake-Crotalus viridis
Racer
Corn snake
Western hognose snake
Night snake
Sonora kingsnake
Texas blind snake
Coachwhip
Striped whipsnake
Smooth green snake
Gopher snake
Long-nosed snake
Mountain patch-nosed snake
Ground snake
Plains black-headed snake
Black-necked garter snake
Western terrestrial garter snake
Checkered garter snake
Western ribbon snake
Plains garter snake
Lined snake

LIZARDS

Chihuahua whiptail
Little striped whiptail
Six-lined racerunner
Checkered whiptail
Plateau whiptail
Collared lizard
Many-lined skink
Great plains skink
Lesser earless lizard
Greater earless lizard
Texas horned lizard
Short-horned lizard
Round-tailed horned lizard
Eastern fence lizard
Side-blotched lizard

TURTLES

Snapping turtle
Red-eared turtle
Yellow mud turtle
Pond slider
Western box turtle
Smooth softshell turtle
Spiny softshell turtle

Source: Reference files of the Museum of Southwestern Biology, University of New Mexico

BIBLIOGRAPHY

Boeker and Boeker , 1972, Winter Golden Eagle Populations in the Southwest.

Boeker, E. L., 1974, Status of Golden Eagle Surveys in the Western States.

Hubbard, John P., 1970, Checklist of the Birds of New Mexico, Ornithological Society Publication No. 3.

New Mexico Game and Fish Department, 1974, Game Bird Studies, PR Project W-104-R-14, Work Plan II, Job 1.

New Mexico Game and Fish Department, 1975, Statewide Fisheries Investigations, F-22-R-16, Job No. I-3.

New Mexico Game and Fish Department, 1975, Statewide Water Pollution Investigations, F-22-R-16, Job No. B-1.

Snyder, W. D., 1973, Investigations of Populations Status of Bobwhite Quail in Eastern Colorado, Colorado Division of Wildlife.

U. S. Fish and Wildlife Service, 1972, Birds of the Maxwell National Wildlife Refuge.

U. S. Forest Service, 1970, Birds of the Commanche National Grassland.

U. S. Forest Service, 1973, Birds of the Kiowa National Grassland.

Wiens, John A., 1973, Patterns and Process in Grassland Bird Communities, Ecological Monographs 43, 1973.

APPENDIX E

AGRICULTURAL PROJECTIONS, METHODS AND RESULTS

APPENDIX E. AGRICULTURAL PROJECTIONS, METHODS AND RESULTS

AGRICULTURAL PROJECTION METHODS

OBJECT OF PROJECTIONS

Projections are needed in order to give planners a view of what economic and environmental problems may appear and/or become more serious in future years. They also aid in showing how contemplated public programs and projects would affect people through changing their economic and environmental conditions.

Certain classes of projections are expected to be a basis for other projections. Population projections are among these "basic projections." The size of the future population is somewhat independent of the future extent of irrigated agriculture. Still, it affects the extent of irrigated agriculture because it largely determines the extent of municipal and industrial use of water, a high-valued use that usually takes economic precedence over crop production due to the workings of free-market forces and the transferability of water rights.

POPULATION PROJECTIONS

For the AWR study area, several different population projection sets are available from two main sources--the U. S. Department of Commerce's Bureau of Economic Analysis and the University of New Mexico's Bureau of Business and Economic Research (BBR).

TABLE E-1. POPULATION PROJECTIONS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

YEAR	BEA-BBR	BBR	1972 OBERS	BEA 1977
1980	39,000	52,200	29,870	37,280
2000	46,300	85,100	27,800	38,850
2020	53,900	120,700	26,590	40,430

Sources: (1) BEA-BBR estimates are from unpublished 1972 materials from Dr. Lee B. Zink, University of New Mexico, Bureau of Business Research.
(2) BBR estimates are from "Projections of the Populaton of New Mexico and its Counties to the Year 2070," by Ralph L. Edgel, UNM, Bureau of Business Research, July 1968.
(3) U. S. Water Resources Council, 1972 OBERS Projections, Series E'.
(4) U. S. Department of Commerce, Bureau of Economic Analysis (BEA) unpublished projections derived from the Regional Economic Monitor System, 1977.

The latter agency developed two alternative sets of population projections for New Mexico counties. One set (the "BBR set") was developed without the benefit of the 1970 U. S. Census of Population results. (See Table E-1). The other set, ("BEA-BBR set") was developed with the aid of the U. S. Department of Commerce Bureau of Economic Analysis (BEA) and the 1970 U. S. census results.

The New Mexico State Engineer Office (SEO) developed alternative sets of projections of water withdrawal and consumptive use for the general categories of water use, based on the BBR and BEA-BBR population projections. Because State Engineer Office personnel had also projected the future aggregate water availability by county, they were able to arrive at projections of remaining future water amounts available for irrigated agriculture. One basis for these projections' size was the fact that crop irrigation is the lowest-valued and residual user of water.

The U. S. Bureau of Economic Analysis (BEA) also developed population projections in the process of developing the OBERS projections of economic activity, earnings and employment for a four-county area consisting of Colfax, Harding, Mora, and Quay Counties, (Water Resource Sub-area #1108) roughly centered in the AWR Basin, New Mexico. Although these OBERS projections employed data from the 1970 population census, they indicated a declining trend in AWR population. Members of the BEA staff developed additional, unpublished population projections for Sub-area #1108 in 1977 when it came to their attention that the population of that area is presently growing, rather than declining.

The BBR population projection is shown (Table E-1), but it was not employed for analysis here. Although it was developed without benefit of the 1970 census results, it could conceivably prove correct.

The BEA-BBR projection of water use by general category is based upon the past popluation growth in the AWR Basin, including the results of the 1970 population census. This projection of water use was used for the projection of the extent of future irrigated crop acreage.

The 1977 unpublished BEA projection of population growth was used to modify the OBERS projections of earnings and employment in the service industries of the study area.

The BEA-BBR projections were thus used for the purpose of projecting water use by general category, and water availability for irrigation. The 1977 BEA projections were used to arrive at new projections of activity in the service industries. Although these two sets of projections disagree to some extent, they both project a moderate rise in population. Also, if the 1977 BEA projections were translated into terms of water use by general category, the residual amount remaining for irrigaton would be expected to be essentially the same as that obtained by use of BEA-BBR projections, (the projections that were in fact used for that purpose).

FOCUS OF PROJECTIONS

Because the focus of this study is on agriculture and public programs that will affect mainly agriculture, the study projections dwell on agriculture. Where other types of projections are developed here, they are mainly intended to estimate the effects on non-agricultural activity resulting from changes in public programs related to agriculture. Future activity in certain basic industries such as mining and most manufacturing has not been projected expressly for this study. Instead, the Water Resources Council's existing OBERS (Series E) mining and manufacturing projections have been presented here.

The projections of future agricultural production mentioned below are of two types: (1) projections based upon the past local trends of individual crops' acreages, and (2) OBERS projections based ultimately on projected National aggregate demand for agricultural commodities.

CROP PRODUCTION

The projections based upon past crop acreage trends were teamed with projections of local crop yields developed by the AWR Basin Study Field Staff to arrive at projections of local production. The OBERS crop projections, in contrast, began with the projected regional crop production share of National production and preceeded toward cropland acreage projections by employing OBERS projected state-average yields. The OBERS projections of National commodity amounts represent the expected future aggregate National and export demand. OBERS regional projections consist of National aggregate demand apportioned among regions essentially according to each region's traditional share of the National and export markets. In the case of the Sub-area #1108, the OBERS projections are based on the assumption that the effects of existing projects on crop production in that Sub-area will remain constant throughout the period from 1972 through 2020.

To form an idea of the future level of agricultural earnings, and employment and the future level of activity in local industries affected by agricultural activity, it is necessary to make estimates of future agricultural production and land use. In an analysis of what effects will ensue from certain contemplated USDA investments in natural resources conservation and/or development, it is usually first necessary to estimate what will happen to agricultural production and land use in the event that USDA programs simply remain at their <u>status quo</u> level. Often, such estimates indicate that increasing production and resource development will occur in the future even without any change in the ongoing USDA program levels. To take such estimates into account is an aid in preventing an exaggerated estimate of the future effects of contemplated USDA program additions and/or accelerations.

Without New Programs

The expected level of agricultural development in future years without new public programs is described below. In this framework, the existing and on-going projects and programs, to a large extent, are considered part of expected future conditions. The conditions described include projections of production, employment, income, water requirements, and land requirements.

Assumptions and Methodology

Future agricultural development and production is projected here on an assumption that gives the basin's traditional share of U.S. production much less weight than is assumed for the OBERS projection.* (See Table E-2.) The objective here is to project what may happen in future agricultural production, and view OBERS projections only as a clue to a practical upper limit on effective aggregate demand for the basin's products.

* Defined in Glossary

TABLE E-2. PROJECTIONS OF CROPLAND USE AND PRODUCTION, 1980, 2000 AND 2020 WITHOUT INCREASED USDA PROGRAM, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

CROPS	1980 LAND AREA (Acres*)	1980 PRODUCTION (Specified Units)	2000 LAND AREA (Acres*)	2000 PRODUCTION (Specified Units)	2020 LAND AREA (Acres*)	2020 PRODUCTION (Specified Units)
Irrigated Crops						
Cotton	1,050	720 bales	0	0	0	0
Barley	2,230	111,580 bu. 1/	2,380	159,400 bu. 1/	2,540	198,360 bu. 1/
Corn, grain	7,390	842,580 bu.	12,910	1,849,110 bu.	16,910	2,758,190 bu.
Corn, silage	8,380	134,000 tons	7,070	141,400 tons	8,940	223,500 tons
Sorghum, grain	18,240	1,413,970 bu.	14,420	1,271,840 bu.	17,380	2,024,770 bu.
Sorghum, silage	6,110	103,870 tons	1,330	27,930 tons	1,240	31,000 tons
Wheat	18,950	777,750 bu.	19,650	1,089,450 bu.	23,920	1,783,470 bu.
Alfalfa hay	24,720	100,980 tons	25,730	118,880 tons	26,440	133,520 tons
Other hay	18,730	26,410 tons	15,550	24,720 tons	16,670	28,420 tons
Other harvested crops 1/	3,340		3,820		3,820	
Irrigated pasture 2/	53,580		58,680		58,620	
Total Irrigated Crops 3/	162,720		161,540		176,520	
Dryland Crops						
Sorghum, grain	28,320	539,600 bu.	28,320	890,240 bu.	28,320	1,107,880 bu.
Sorghum, silage	14,050	102,780 tons	8,000	73,560 tons	6,790	75,790 tons
Wheat	123,900	1,805,220 bu.	128,520	2,375,050 bu.	131,960	2,953,920 bu.
Other dry crops 1/	730		2,200		1,130	
Total Dry Crops	167,000		167,040		168,200	
Cropland unharvested 4/	360,790		360,750		359,590	
Total dry cropland 5/	527,790		527,790		527,790	

* To convert to hectares, multiply by 0.4047.

1/ Utilizes OBERS projections, Series E'.
2/ Irrigated pasture acreage figures are residual amounts equal to the difference between total projected irrigated land acreage planted in harvest crops and projections based on New Mexico State Engineer estimates of water depletion by irrigation.
3/ Based on New Mexico State Engineer estimates of depletion, unpublished.
4/ Includes fallow, idle, and crop-failure acreage, plus land in cover crops, legumes and soil-improvement grasses.
5/ Assumed to remain at 1974 level through year 2020.

Sources:
1. USDA, Statistical Reporting Service and New Mexico Dept. of Agriculture <u>New Mexico Agricultural Statistics</u>, Series 1959-1974.
2. Unpublished information from USDA field specialists stationed in the Arkansas-White-Red River Basin study area, New Mexico.
3. New Mexico River Basins Staff, USDA; unpublished projections of future crop yields.
4. New Mexico State Engineer Office; unpublished projections of irrigation water availability.

The method of making agricultural projections for future conditions, without a basin plan, is essentially an extension of past trends in acreages of the major crops by counties. This was modified by the projected supply of irrigation water as related to the expected future demands for water in competing uses and the projected limits of underground water supplies. (See Tables E-3 and E-4.)

After projections of crop acreages were obtained, they were translated into agricultural production by means of yield projections developed by the Economics, Statistics, and Cooperatives Service and Soil Conservation Service as an alternative to the state average yields developed by OBERS. (See Table E-5.) These yield projections utilize a process which smoothes the past trend and then extends it into the future. Adjustments were made by the Soil Conservation Service agronomist. These yield trends were then extended to 1980, 2000, and 2020 values.

The data for extending the trend in crop acreages were obtained from a 16-year series compiled by the State of New Mexico and by USDA's Statistical Reporting Service. These data were formed into trend line equations. The trend lines were then extended to years 1980, 2000, and 2020 for individual crops for each county.

To provide for the changing institutional effects on crop production, certain crop acreage series were shortened before trend calculations were made by removing some annual figures. This process was dependent on interpretative reports by U. S. Department of Agriculture personnel located in each county. They were asked to interpret, in terms of economic and institutional factors, deviations in the 16-year series of acreages of certain selected crops whose acreage trends have been discontinuous. The main institutional effects that were identified as causes of discontinuous acreage trends were the recent decline of cropland held in "set-aside" and other federal programs, including a now-discontinued program that had the effect of encouraging production of hay, primarily in Mora County.

The projected values thus obtained for individual irrigated crops in each county were then examined in order to determine if the projected future irrigation water supply in each individual county would limit the extent of irrigated crops. It was apparent that the irrigated crops of Curry county were projected to exceed the projected water supply in benchmark years 1980, 2000, and 2020. The projected acreages for these crops were all proportionally reduced to a level consistent with the projected amounts of available irrigation water.

The projected supply of irrigation water for the basin's counties was obtained by use of unpublished data supplied by the New Mexico State Engineer Office. Those projections included declines in availability of ground water in some locales.

TABLE E-3. ALTERNATIVE PROJECTED WATER DEPLETION DEMAND BY USES, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Use	BBR 1/			BBR-BEA 2/		
	1980	2000	2020	1980	2000	2020
	1000 Acre-Feet			1000 Acre-Feet		
Urban	3.1	7.8	15.3	2.1	3.5	5.6
Rural domestic	1.0	1.2	1.6	1.0	1.1	1.4
Irrigation	229.5	235.3	256.9	229.5	235.3	256.9
Manufacturing	.2	.4	1.0	.1	.3	.4
Minerals	1.2	4.0	10.8	1.2	4.0	10.8
Livestock	15.3	16.7	16.9	15.3	16.7	16.9
Power	.2	14.6	68.5	.2	14.6	68.5
Fish & Wildlife	10.5	11.2	11.2	10.5	11.2	11.2
Recreation	0	.1	.1	0	0	0
Reservoir evaporation	74.5	76.8	76.8	74.5	76.8	76.8
TOTAL	335.5	368.1	459.1	334.4	363.5	448.5

1/ These water demand projections are based on regional population projections by the University of New Mexico, Bureau of Business and Economic Research (BBR), 1968.

2/ BBR-BEA water demand projections are based on regional population projections made by BBR, which utilized 1972 state population projections from the U. S. Bureau of Economic Analysis as a source.

Source: U. S. Bureau of Reclamation, Water Resources Assessment, 1976.

TABLE E-4. PROJECTED IRRIGATED ACREAGE FROM SURFACE AND GROUND WATER SOURCES REMAINING AFTER SATISFYING PROJECTED NON-AGRICULTURAL DEMAND 1/ - ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

		Acres			
Year		1969	1980	2000	2020
AWR Total		124,250	162,720	161,540	176,520
Colfax	ground	1,000	920	920	870
	surface	25,370	21,000	18,920	15,990
	total	26,370	21,920	19,840	16,860
Curry	ground	17,780	20,000	0	0
	surface	0	0	0	0
	total	17,780	20,000	0	0
Harding	ground	4,210	9,300	13,100	13,200
	surface	0	0	0	0
	total	4,210	9,300	13,100	13,200
Mora	ground	0	0	0	0
	surface	12,600	12,920	12,220	11,660
	total	12,600	12,920	12,220	11,660
Quay	ground	2,350	4,240	11,080	15,310
	surface	28,270	34,070	34,080	34,000
	total	30,620	38,310	45,160	49,310
San Miguel	ground	150	0	0	0
	surface	3,050	3,280	3,310	3,400
	total	3,200	3,280	3,310	3,400
Union	ground	25,040	52,780	63,730	77,950
	surface	4,430	4,210	4,180	4,140
	total	29,470	56,990	67,910	82,090

1/ Excludes nuclear power plants in Mora and Union Counties

Source: Unpublished estimate, based on OBERS 1968 projections, by State Engineer Office, New Mexico, 1977.

TABLE E-5. PROJECTIONS OF CROP YIELDS, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Crops		1980	2000	2020
		Units per acre		
Irrigated crops				
Cotton	(bales)	.69	.92	1.15
Barley	(bu.)	50	67	78
Corn, grain	(bu.)	114	143	163
Corn, silage	(tons)	16	20	25
Sorghum, grain	(bu.)	78	99	117
Sorghum, Silage	(tons)	17	21	25
Wheat	(bu.)	41	55	75
Alfalfa	(tons)	4.5	5	5.4
Other hay	(tons)	1.5	1.7	1.8
Dryland crops				
Sorghum, grain	(bu.)	19	31	39
Sorghum, silage	(tons)	7.3	9.2	11.2
Wheat	(bu.)	15	19	22

Sources: (1) USDA Statistical Reporting Service and New Mexico Department of Agriculture; New Mexico Agricultural Statistics, Series 1959-73.

(2) USDA Soil Conservation Service and Economics, Statistics, and Cooperatives Service, joint estimates of future yield levels made by members of the AWR Basin Study field-party staff.

Essentially, the total future water supply for consumptive use, without plan, is equal to the present annual surface and groundwater consumptive use, plus or minus future changes in annual groundwater consumptive use. Projected declines in groundwater availability were taken into account in the projection of future water supplies. The projected irrigation water supply was obtained by subtracting the amounts of all other more highly valued uses from the projected supply.

The projected nonirrigation consumptive uses of water are assumed to be the same as the consumptive use demand estimates which were projected in Table E-3 of this chapter.

Nature of Projected Cropland Changes

The amount of irrigated acreage is projected to show a net increase from 155,800 in 1974, to 162,720 in 1980, and 176,520 in 2020. The land presently being converted to irrigation is mainly former rangeland that has not been dry-cropped. The water source is newly tapped groundwater supplies. Future irrigation development is expected to continue the trend of conversion of rangeland through development of ground water sources.

A decrease is projected for cropland presently irrigated by means of mining water from a declining groundwater reservoir. The extent and location of this projected decrease are 20,000 irrigated acres in Curry County between 1980 and 2000. The affected irrigated land is expected to revert back to the dry cropland category, but not necessarily to increase the future annual amount of dry cropland harvested.

Dry cropland available is assumed to continue at the 527,800-acre level of 1974 through Year 2020. 1/ The extent of dry cropland harvested annually is projected to rise to 167,000 acres in 1980 from 99,000 acres in 1974 and to remain almost unchanged through Year 2020. The implication of this, is that some 360,000 acres of dry cropland that is assumed to be available for planting will not be harvested in a typical future year.

In recent years, about 140,000 acres annually of available unharvested dry cropland has been used as cropland pasture. If this pasture amount is assumed to remain constant through 2020, some 200,000 remaining acres of dry cropland can be expected to be fallow and idle, or to be in cover crops, legumes, and soil-improvement crops each year. Any given parcel of dry cropland might be expected to rotate periodically among the classifications of harvested, fallow, pasture, and soil-improvement crops, while the grand total for each class remains roughly constant.

OBERS Agricultural Projections

The OBERS Series E' projections (Table E-6) are based on the assumption that the U. S. population will grow from 223.5 million persons in 1980 to 297.1 million in 2020. The Arkansas-White-Red River Basin, New Mexico, was projected to fill a certain share of the future U. S. food and fiber production.

The OBERS projections, in their released form, pertain to Water Resources Sub-area #1108, a four-county area (Colfax, Harding, Mora, and Quay) that lies almost entirely within the basin. The OBERS numbers were expanded to the whole Arkansas-White-Red River Basin study area, as follows:

1. 1969 Production for each significant crop type for the counties or county portions in the basin was recorded and, for all counties, totaled together.

1/ The 1974 available cropland acreage is shown in Chapter 3, page 3-24, in the context of current data for other major land uses.

TABLE E-6. OBERS-BASED PROJECTIONS OF CROP ACREAGE AND PRODUCTION, 1980, 2000, and 2020
ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

CROPS	1980 LAND AREA (Acres*)	1980 YIELD	1980 PRODUCTION (Specified Units)	2000 LAND AREA (Acres*)	2000 YIELD	2000 PRODUCTION (Specified Units)	2020 LAND AREA (Acres*)	2020 YIELD	2020 PRODUCTION (Specified Units)
Cotton	1,980	1.23	2,440 bales	1,740	1.26	2,190 bales	1,710	1.28	2,190 bales
Barley	1,460	76.4	111,580 bu.	1,600	99.3	159,400 bu.	1,710	115.9	198,360 bu.
Corn, grain	7,750	80.0	619,960 bu.	4,430	108.4	479,740 bu.	1,800	128.5	231,260 bu.
Silage	15,660	13.9	217,750 tons	11,790	18.9	222,800 tons	8,620	25.5	219,780 tons
Sorghum, grain	54,860	98.0	5,376,240 bu.	66,050	112.0	7,397,380 bu.	50,120	150.0	7,518,660 bu.
Wheat	74,040	38.9	2,880,080 bu.	100,160	42.6	4,266,780 bu.	103,030	45.9	4,729,010 bu.
Hay	28,950	4.5	130,260 tons	41,080	4.56	187,340 tons	36,530	6.33	231,250 tons
Other harvested crops	4,070			6,020			4,990		
Irrigated pasture	11,940			22,920			26,750		
Total Crop Acreage	200,710			255,790			235,260		

* To convert to hectares, multiply by 0.4047.

Sources:
1. U. S. Water Resources Council; unpublished OBERS projections backup materials, Series E'.
2. U. S. Department of Agriculture; unpublished estimates of partial-county crop production proportions.
3. U. S. Census of Agriculture, 1969.
4. New Mexico River Basins Staff, USDA; unpublished projections of future crop yields.
5. New Mexico State Engineer Office, unpublished projections of irrigation water availability.
6. U. S. Bureau of Reclamation, New Mexico Water Resources Assessment, 1976.

2. For each projection year, an index number reflecting growth or decline from 1969 for each crop type projected by OBERS was obtained, using the OBERS production amounts for each projection year.

3. 1969 Production amounts were multiplied by the index numbers obtained in (2) above.

4. Resulting Arkansas-White-Red River Basin OBERS projections of production were then divided by OBERS state-average crop yield projection numbers to obtain projected crop acreages.

The OBERS projections of crop production in the basin are not in agreement with the without-plan projections of Table E-2. In the case of most crop types, acreages and production, the OBERS projections exceed the without-plan projections.

The most striking feature of the OBERS Series E' projections is that sorghum grain production was projected to rise above its current level by 1980 and to continue increasing through Year 2020. According to New Mexico Agricultural Statistics, the average annual production in the four counties of WRSA #1108 in 1974-76 was 388,700 bushels of sorghum grain, with 476,200 bushels being produced in 1975. However, the OBERS Series E' projection places sorghum grain production for 1980 at 1,213,100 bushels in WRSA #1108. The OBERS projections methods thus would appear to call for too much sorghum grain production in 1980 and perhaps later years. The OBERS procedures' assignment of resources to massive production of sorghum grain may possibly have resulted in compensatingly lower OBERS projections for other crops than the OBERS procedures would have called for if less sorghum production had been projected. The latter statement is based on the OBERS practice of projecting each major region's share of aggregate national agricultural production and further disaggregating the regional share into finer subregions. Inherent in this process is the loss of projection validity that tends to ensue from projecting more specific crop types and geographic areas, rather than more general crop classes and larger geographic areas. An example would occur in the assigning of future feed grain production of a region among its subregions. If more of one feed grain is assigned to one of the subregions, less of other feed grains thereby tend to be assigned to it in projections.

The OBERS projected amounts of crops are overall somewhat larger for the AWR Basin than the amounts in the without-plan projections. (See Table E-7.) Exceptions are corn for grain and silage. The differences in these crop amounts are essentially due to the differences in the OBERS procedures and trend extension method used for without-plan projections.

TABLE E-7. DIFFERENCE BETWEEN OBERS SERIES E' AND WITHOUT-PLAN PROJECTIONS OF ACREAGE AND PRODUCTION, 1980

Crop	Acreage Difference	Production Difference
(Minus amounts show OBERS smaller than without-plan)		
Cotton	934	1,720 bales
Corn, grain	360	-222,620 bu.
Silage	-12,875	-122,900 tons
Sorghum, grain	8,300	3,422,670 bu.
Wheat	-68,812	297,110 bu.
Hay	-14,500	2,870 tons
Irrigated Pasture	41,640	

LIVESTOCK PRODUCTION

Beef and veal production projections are shown in Table E-8. Cattle production is by far the most significant portion of agricultural production and accounted for about 90 percent of the agricultural sales in recent years. Projecting future beef production that would occur, without improved resource development and management systems, was accomplished as described in the following paragraphs.

The basin's rangeland grazing capacity, as presently managed, was assumed to be used to its practical upper limits. Water Resources Council projections of demand for beef and veal indicate that demand will cause

TABLE E-8. PROJECTED BEEF AND VEAL PRODUCTION, WITHOUT-PLAN, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO

Products	1969	1980	1990 1/	2000	2020
			(1000 lb.)		
Beef and veal	139,260.1	206,789.5	207,771.3	208,753.1	208,730.0

1/ By interpolation between 1980 and 2000 projected values.

Sources:
(1) U.S. Census of Agriculture, 1969.
(2) New Mexico Agricultural Statistics, 1973-75.
(3) New Mexico SEO unpublished projections of irrigated cropland.
(4) U. S. Soil Conservation Service; unpublished estimates of future range productivity.
(5) Projections based on procedures outlined in Chapter 4 text.

cattle production to remain at the limit imposed by the range carrying capacity including irrigated pasture and other grazed cropland. This holds true from the present time to the year 2020. Future increases in cattle production, without improved management and development of the range resource, are likely to be achieved only as a result of irrigated cropland use being changed from harvested crop production to irrigated pasture and forage crops.

The projection of beef production was made by choosing representative recent years' cattle numbers, by county, and by converting these cattle numbers into terms of annual beef production. Additional acreage of irrigated cropland was projected to change from crop production to irrigated pasture (based on historical trends) with no significant effect on total irrigation water depletions.

Future strong grain export demands and energy price increases will impose cost and price pressures on the livestock industry. This may produce changes such as less grain feeding of livestock with an increase in use of forage, pasture, and rangeland for meat production. The end result may be an increase in the slaughter of grass-fed cattle, as opposed to the present practice of finishing market cattle on grain.

Acreages of cropland assumed to become additions to the existing land in irrigated pasture were translated to annual beef production. The result, for each projection year, was added to the present level of beef production in order to arrive at projected production for the time frame years. The projected production of beef cattle shows an increase from 1980 to 2020.

Numbers of cattle on ranches in the counties were obtained from annual summaries of New Mexico agricultural statistics gathered jointly by the Statistical Reporting Service, USDA, and the New Mexico Crop and Livestock Reporting Service. An estimate of annual production (373.67 lbs.) per head of cattle on ranches was made by the use of the average state proportion of cattle on ranches to the annual cattle production (in live weight) over the period 1967-1974.

The U. S. Water Resources Council's Series E' OBERS projections for livestock production are shown in Table E-9. OBERS projections of beef and veal production were used only for comparison purposes. The other OBERS livestock projections shown in Table E-9, along with the projections of beef and veal production in Table E-8, were used for the purpose of projecting the value of agricultural production and earnings, without plan. (See page 4.26).

TABLE E-9. OBERS PROJECTED LIVESTOCK PRODUCTION, ARKANSAS-WHITE-RED RIVER BASIN, NEW MEXICO (IN THOUSANDS OF UNITS)

Products	1969	1980	1990 1/	2000	2020
Beef and veal, lb.	139,260.1	207,985.9	242,650.2	277,314.6	301,820.0
Pork, lb.	3,182.4	4,073.5	4,089.4	4,105.3	3,723.4
Lamb and mutton, lb.	958.9	393.2	326.0	258.9	287.7
Chickens, lb.	20.1	142.9	164.6	186.3	219.1
Turkeys, lb.	35.3	11,546.0	5,773.0	.0	.0
Eggs, doz.	433.0	1,091.1	1,251.3	1,411.5	1,662.6
Milk, lb.	23,782.0	14,269.2	15,220.0	16,171.8	19,025.6

1/ By interpolation between 1980 and 2000 projected values.

Sources: (1) U. S. Water Resources Council, OBERS Series E'.
(2) U.S. Census of Agriculture, 1969.
(3) New Mexico Agricultural Statistics, 1973-75.
(4) New Mexico SEO unpublished projections of irrigated cropland.